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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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The Newcastle Convention.

Early next month the annual conference of the Institute of British Foundrymen will be held at Newcastle-upon-Tyne, under the chairmanship of Mr. Victor Stobie. We are in the privileged position of preparing for press the Papers to be submitted, and whilst comment at this stage on our part would be invidious, we can state in general terms that those so far handled are extremely well balanced and calculated to induce discussion. For the first time in the history of the Institute one of its sub-committees is to present a Report covering the present technical position of the malleable-iron founding industry. This Paper is so important that every member connected with this branch of the industry should make a special effort to attend. Whilst the malleable industry is virtually non-existent on the North-East Coast, they will find much interest in visiting the Close works of Messrs. Armstrong Whitworth (Ironfounders), Limited, where they will see in operation one of the latest rotary pulverised fuel-fired furnaces, which class of furnace is specially suited for the melting of metal for malleable-iron castings.

The non-ferrous foundry executives are especially fortunate this year, as they are to have an address from Dr. W. Rosenhain, F.R.S., who, until lately, was the head of the metallurgical department of the National Physical Laboratory.

To the ferrous metallurgist in co-operation with the iron-foundry owners, a new field of activity is being presented by Mr. J. E. Hurst, who is disclosing the results of his far-reaching researches into the potentialities of heat-treating cast iron; especially alloyed cast iron.

Additional interest is given to this subject by Mr. MacPherran, the author of the American Exchange Paper, as he reviews authoritatively the present position of high-duty cast iron in the States.

A matter of basic interest to steel founders —that of handling—is being introduced by Mr. F. J. Hemming, the managing director of F. H. Lloyd & Company, Limited. Adequately discussed real benefits should accrue to this section of the industry. Steel founders should bear this question of handling in mind when they visit the works of Messrs. Smith, Patterson & Company, Limited, of Blaydon, as few works in Great Britain have tackled this problem more intelligently.

The practical type of executive officer is to be favoured by the presentation of Papers by Mr. Pillon—the French official contribution—Mr. E. Longden and Mr. O'Sullivan. The last named is a new comer as a lecturer. He is on the staff of Messrs. Henry Ford & Son, Limited, of Cork, and no one is better qualified to talk on the quantity production of grey-iron castings than this lecturer. Again, it is the type of Paper, which is presented as a basis for discussion. The organisers of the Convention have arranged for more adequate time than is usually scheduled. Whilst the social side has not been planned on such a generous scale as is customary, a proper balance has been effected. There will be the usual annual banquet, followed by dancing, a reception and a whole-day excursion in the country. An excellent programme has been arranged for the entertainment of the ladies participating. We wish specially and sincerely to assure those in charge of foundries that as a business proposition attendance at the Newcastle Conference by themselves or a member of their staff is a worth-while investment, carrying the promise of a high return for the paltry expenditure necessary.

World Pig-Iron Production.

The production of foundry pig-iron usually remains a fairly constant proportion of the world's pig production, and consequently world pig production is a fairly reliable index to fluctuations in the basic raw material of the foundry trade. The statistics which we recently published of the world's output of pig-iron and ferro-alloys form a conclusive indication of the world-wide nature of the depression in industry. A fall in production peculiar to any one country must give serious cause for thought in that country, for the origins will be due to causes within its control, but there is no doubt that the present trouble is world-wide. The figures were given for 1929 and 1930. For the United Kingdom the production of pig-iron was 7.6 million tons for 1929 and 6.2 million tons for 1930; it will be observed that the 1930 production is 81.5 per cent. of the 1929 production. The production of the British Empire as a whole was 10.5 million tons for 1929 and 8.6 million tons for 1930, so that the 1930 production was 82 per cent. of the 1929 production.

If we turn to the principal foreign countries we find that the Belgian production in 1929 is 4.0 million tons against 3.3 million tons in 1930, which gives a figure of 82.5 per cent. For Germany, 13 million tons were produced against 9.5 million tons in 1930, the proportion being 73 per cent. The French production, on the other hand (including the Saar), has only fallen from 12.3 million tons to 11.7, the proportion being 95 per cent. We may infer that French political views during the past three years have been governed to a large extent by the relatively favourable position which the French industries have enjoyed. Recent trade figures show that France is now suffering much in the same way as other countries. Taking the total production of foreign countries, the output fell from 86.7 million tons in 1929 to 71.1 million tons in 1930, the proportion being 82 per cent.

It we take the figures for the world output, the total production for 1929 was 97.2 million tons and, for 1930, 79.7 million tons, the proportion again being 82 per cent. (approximately). It will be seen that the proportion of pig-iron produced in Great Britain has remained much the same during these two periods in spite of the special conditions which surround blast-furnace production in this country—that is in

(*Concluded on page* 316.)

Mould Density Determination.

By Wm. Y. Buchanan.

In a Paper entitled "Sand Testing in the Foundry," written by the present author and published in The Foundry Trade Journal, February 11 and 18, 1932, considerable space was devoted to a "Penetration Method" of measuring the degree of ramming in moulds, and expressing this either in millimetres penetration, or by means of similar tests on B.C.I.R.A. compression strength test-pieces of various densities and a graph therefrom, in apparent density at a stated moisture content.

For a full description of the apparatus, the reader is referred to that Paper, and for further details of the B.C.I.R.A. methods to Dr. Skerl's Paper in The Foundry Trade Journal, July 23 and August 6, 1931. Briefly, the principle of the penetration method is that a ½-in. dia. steel wire is driven into the sand by the blow of a falling weight under standard conditions.

It has been previously stated that by this method considerable variations in ramming were found in different parts of a mould, and even in the same part of a hand-rammed mould, and that such variations could be investigated by this method. The example in the illustration (Fig. 1) shows a half-mould made by a single squeeze in a pneumatic moulding machine, and the comparison of this with hand-rammed moulds is interesting.

The sketch is to scale, and as shown the pattern is off centre and the effects of this are shown in the figures. The numbers placed in the sketch give the penetration in millimetres, and the point alongside each marks the exact position at which the test was made. The whole surface can thus be mapped out as desired. Assuming that the sand has been tested for permeability, compression strength and moisture (in B.C.I.R.A. units in this case), the penetration figure gives immediately the density, and from that the strength and permeability. The scales penetration to density, density to permeability and density to strength are constructed from graphs and placed in the illustration for convenience in reference in this case.

The moulding box, which tapers inside as shown, is, of course, not suitable for this type of ramming, and this half-mould was given a preliminary hand-ramming round the edges before squeezing. The figures near the edges of the box show a tendency towards the irregularity usually associated with hand-ramming. The top of the pattern A has been subjected to a relatively high pressure, which has resulted in a compression strength of 9 lbs. per sq. in. and a permeability of 60 seconds.

The uniformity of degree of ramming in this part is clearly shown; while tests taken at the level B show that the effect of the pattern being off centre is slightly harder ramming, with its inevitable effect on strength and permeability of the mould at the side nearest the box.

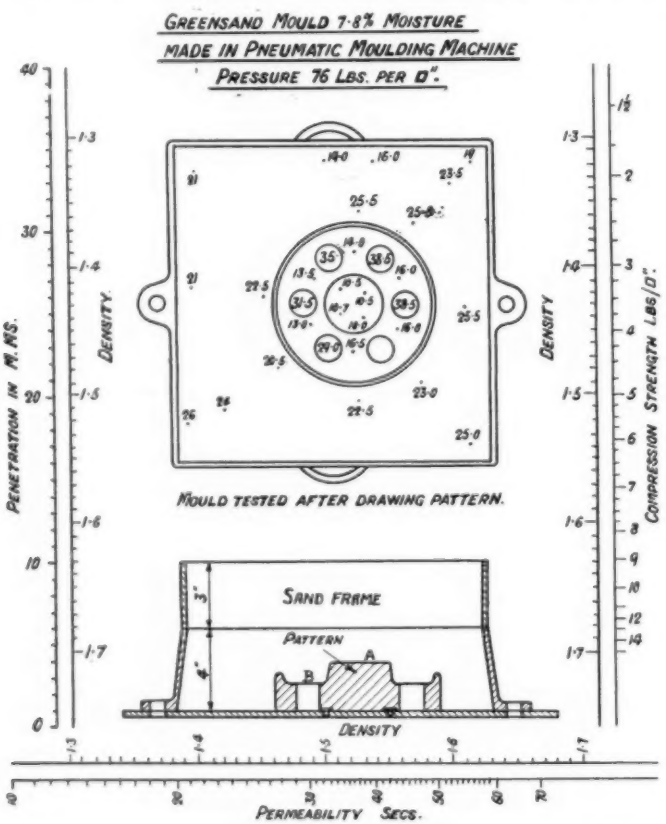


Fig. 1.—Showing Practical Correlation of Penetration Figures with Density, Compression Strength and Permeability.

To obtain a good degree of ramming in holes in the pattern such as those shown, by a single squeeze is very difficult, and as is to be expected, the strength in the resulting cores is very low with the permeability very high.

From consideration of these tests it would seem that the block used to squeeze the sand down into the box should be shaped somewhat to the contour of the pattern to give a preliminary squeeze, the loose shape removed and a fresh lot of sand applied. This, of course, does not apply to shallow patterns, or to methods of squeezing the pattern upwards into the sand, or to jolt ramming.

As a check on routine production where liberties may be taken with the amount of sand, the number of jolts in jolt ramming, or the pressure in squeezing methods, a penetration figure already associated with good practice would simply have to be maintained.

(*Concluded in next column.*)

(*Concluded from previous column.*)

The advantages of such a control are:—(1) The ability to check any mould at a moment's notice; (2) having determined the most suitable density for a particular job and class of sand, this can be adjusted with certainty and checked as often as necessary, and (3) by shaping the block as already mentioned, or any other method with a similar object, the degree of ramming of any part with relation to the rest of the job can be adjusted.

The above notes are intended to illustrate the practical application of the method rather than to show the solution of a problem.

High import duties on motor-car bodies were imposed by the Irish Free State Government by an Order which came into operation recently. The duties cover a wide range of vehicles, and apply whether the bodies are imported separately or along with the chassis. On the bodies of private cars the duty is 75 per cent., or £60, whichever is the higher, and on omnibus bodies it is 150 per cent. Imperial preference rates will be granted in all cases. In the case of the 75 per cent. tariff, British and Dominion motor-car bodies will pay 50 per cent., and in the case of the 150 per cent. tariff they will pay 100 per cent.

Random Shots.

"Marksman" rejoices to learn that the Post Office has at length adopted the business reply-card system. He rejoices, that is, in moderation. For the system threatens to cut off one of the channels whereby, in the course of a year, he acquires a not inconsiderable selection of three-halfpenny, penny and halfpenny postage stamps. It is really curious how many of us have that weakness of peeling off the stamps from any "stamped-addressed envelope" we don't intend to use. More curious still, in "Marksman's" own particular case, is that the salvaged stamps rarely seem to get used. Their ultimate fate, like Jude, is somewhat obscure, but generally they are lost before they can be destroyed in the process of attempting to paste them up.

* * *

The existence of these gumless stamps—as is the existence of any gumless thing that should be and was once but is not now gummed (*e.g.*, labels, core oils, etc.)—is really a sinister matter, because one is often tempted, by reason of the knowledge of their existence, to neglect to stock stamps that *are* gummed. "Marksman" has actually walked by Post Offices and deliberately refrained from buying stamps because of these miserable, unattachable scraps of paper. How many of his readers, he wonders, have behaved in precisely the same way, and having found the stamp, not found the paste (or gloy, or glue, or what will you call it?); or discovered that Tommie has poured it on the flower beds to stop the birds picking up the seeds?

* * *

"Marksman" once knew a man who depended upon such a stamp to send in his entry in a crossword competition. He found that his nephew had disposed of the only tube of paste he had. The entry, which alas! was thus never entered, proved to be correct. The man was so infuriated that he apprenticed his nephew to a foundry owner. When the news was published, however, that the successful competitors were so numerous that the share of each in the prize amounted to no more than one-eighth of a penny, the uncle relented. He received back the boy from the foundry and placed him, instead, in a West End motor showroom. And there he is to-day. His name, if you would like to know it, is Anthony de Vere; he would, "Marksman" fears, never have been happy in the foundry.

Marksman.

The Manufacture of Sand-Spun Pipes.*

By J. B. Allan.

The Staveley Company and its direct lineal ancestors have smelted iron ore within the boundaries of the present works for the last 250 years, while its books of accounts form a continuous record from 1682 to the present time. For about the last 100 years, cast-iron pipes have formed the main outlet for the iron so made. Again, the employees even now are largely drawn from the immediate neighbourhood, and as in many cases, their fathers and grandfathers have been engaged in pipe making under the same company, it may be fairly said that pipe making is in their blood. Hence, any new methods or modifications of existing methods of pipe manufacture have always been studiously and generally critically examined at Staveley. Many experiments have been carried out at different times, but until last year the vertically cast pipe, cast in pits, held undisputed sway throughout the Staveley Works. Of recent years the output of pipes made in this way has been approximately 100,000 tons per annum.

Birth of Centrifugal Castings.

As regards methods of manufacture, that which applied at Staveley also applied in general to the rest of the world until the beginnings of centrifugal casting, immediately prior to the war, and so far as this country was concerned, until immediately after the war. The earlier practicable methods of centrifugal casting all made use of metal moulds, water cooled or otherwise, and it was not until the development in America of centrifugal casting in sand moulds that the Staveley Company felt satisfied that the correct method of centrifugally casting pipes had been attained. Hence, in 1929 it was determined to put down a plant for the manufacture of cast-iron pipes of sizes from 4 to 12 in., inclusive in sand moulds by a centrifugal process, under licence from the Sand Spun Corporation of America.

Work was commenced on a site near by the existing foundries in the early part of 1930, and the first pipe was cast on June 3, 1931. One-shift working immediately followed, and in the following October two-shift working, a condition which has been maintained from that time, and one which affords some criterion of the value of the pipe in the eyes of consumers.

The plant is housed in a steel-framed building 420 ft. long by 150 ft. wide, and 63 ft. high to the eaves. This building is divided into three main bays, while in addition there is a lean-to running the full length of the building on the south side, together with three secondary buildings running at right-angles to this, each of which contains a proving and dipping unit. On the north side of the main building an open overhead crane grantry covers the raw-material stockyard.

On the north side there is the raw-material stock bay, and alongside it are three cupolas, which tap into the first bay of the main building. This bay also contains the sand-reconditioning plant. The second bay, which in effect is the main one, contains the mould-making equipment, the centrifugal machines, or spinners as they are called, the cooling gantry and the strippers. The remaining bay of the main building and the lean-to house the grinding equipment, and three special lathes for turning and boring such pipes of this type as may be required.

Melting Plant.

Each cupola is provided with a tilting tray pneumatically operated. This tray when in the horizontal position rests upon a weighing machine table. Raw materials, therefore, are dumped by one of the two magnet cranes direct from stock-yard to tilting tray where they are weighed and then discharged into the cupola.

The melting plant consists of three cupolas of 4 ft. 6 in. dia., designed and constructed by the Company's own staff. Each is of 15 tons per hour capacity, and is provided with two rows of tuyeres, five in each row. Each tuyere is provided with a damper so that effective distribution of the blast may be obtained.

The cupolas are of the drop-bottom type, and were designed for uninterrupted working periods of 24 hours each. This they have proved well able to do. Blast air is supplied by one of two electrically-driven centrifugal fans, each capable of delivering 6,000 cub. ft. per min., against a head equivalent to 36 in. W.G. when running at 1,700 r.p.m.

Mould Making Equipment.

The flasks for containing the sand moulds are cast-iron cylinders drilled to ensure satisfactory venting, and fitted with two steel tyres upon which they run during the spinning operation. The bell-mouthed end of the flask has bolted to it a detachable ring. This ring serves several purposes. The first is to fit the socket pattern, thereby ensuring concentricity at this end between the pattern and the flask. Its second purpose is to act as a seat upon which the load is taken, while its third is achieved by means of cotter-holes and cotters, whereby the socket-core is secured in the mould.

At the opposite, or spigot end, a flange is secured to the flask. This serves two purposes, that of a sand hopper and as a centering device between the top of the pattern and the flask, periphery of the flask-flange forming the machined face of the flask for this purpose.

The second purpose served by the flask-flange, which has a plate bolted to it, called the spigot-end plate, has a groove on its inner surface into which sand is rammed, thus forming a sand inset against which the metal of the pipe abuts. A hole in the middle of the spigot-end plate is the entrance through which the molten metal is poured.

The various items which go to make up the whole assembly are the flask itself with its vent holes, the sand-mould, and the pipe, while the socket core, which is of oil sand, is at the bottom with its securing plate in position. Thus, the molten metal comes in contact with sand only, nor does any form of chilling enter into the process. Hence, the pipe is a sand casting just as its cousin, the pit cast pipe is a sand casting. Those qualities such as lack of brittleness, ease of cutting, etc., with which engineers have been familiar for generations, qualities largely conferred by reason of the fact that the bed of the molten metal is sand, its natural one, are all contained in the sand-spun pipe, equally with the pit cast one. The only feature of the manufacturing process of the sand-spun pipe which is common to other centrifugal processes is that centrifugal action enters into all of them.

One great advantage, however, which the sand-spun pipe possesses over the pit cast one, is that it is possible to guarantee that the spun pipe will be absolutely free from gas cavities and non-metallic inclusions. It is obvious that apart from the centrifugal machines, all the plant involved can be equally well used for the manufacture of pit cast pipes were a pit available.

Moulding Methods.

The machines used are Herman plain jolters. These machines were made in America, and form the only non-British production in the plant. There are four duplicate machines each capable of handling loads up to 12 tons each. The jolters are carried on reinforced concrete foundations constructed on piles. The foundations are isolated from each other and from the foundations of the building in order to minimise the transmission of vibration.

For pipe sizes of from 4 to 8 in. inclusive, three moulds at a time are jolted on one machine, while for sizes from 9 to 12 in. inclusive, two only are made. Hence, either two or three sets of moulding tackle are used in connection with each jolter.

A set of moulding tackle consists of five items:—(1) A socket-head pattern; (2) a body pattern; (3) a sand hopper; (4) a spigot-beading plate, and (5) a blacking hopper. The body patterns are centred with the socket patterns by means of a tapered spigot and socket joint, and as has been mentioned before, the whole pattern assembly is centred with the flask by means of the socket-end ring at the bottom and the sand hopper at the top. When the flask has been filled with sand, the hopper is removed, the top end of the mould hand-rammed, and the groove for the bead formed by dropping the beader plate over the pattern, and ramming this down until the plate is flush with the flask flange.

The beader plate is then removed, and the spigot-end plate placed in position and bolted there. The blacking hopper is then placed on the spigot-end plate and the mould flushed with blacking. The blacking hopper is fitted with a spring-loaded leather-faced valve. On depressing this valve the blacking mixture is released. After the jolting operation has been completed, the body patterns are withdrawn from the moulds by means of an electric winch, capable of lifting 60 tons. The flasks are moved from the horizontal to the vertical position in which the moulds are made and *vice versa*, by means of hydraulically-operated tilting tables.

After the moulds are complete the flasks are rolled by hand from the tilting tables to the adjacent gantry; from there they are removed two at a time by one of the three special manipulator-type overhead cranes to the mould-drying station and there deposited on another gantry. Here the moulds are skin-dried from the spigot end by burners, using coke-oven gas. These burners are so designed as to inject large quantities of air through the moulds, in addition to the products of combustion. This arrangement enables the moulds to be rapidly dried without burning the blacking.

Suitable portable deflectors are used at the socket end to cause the gases to scrub the walls of the moulds at this point. On completion of drying, the flasks are again lifted and placed on further gantries, immediately adjacent to the particular spinners which are to be used. Here further gas jets keep the moulds warm and prevent condensation until the socket cores are fitted, immediately prior to spinning.

Spinners.

There are seven centrifugal machines or spinners, all duplicates except in respect of driving-pulley diameters where some special speed condition is required, as, for example, in the small-diameter pipes. Each machine consists of a built-up steel box framework, rigidly bolted to a heavy reinforced-concrete foundation and contains two driving and two idle rollers upon which the flasks rest. The roller shafts are supported by heavy-type roller-bearings. Extensions of the driven roller shafts are fitted with brake-drums and driving-pulleys; the brake-shoes are Ferodo-lined and enable the rotating parts to be rapidly brought to rest.

Two 15-h.p. motors drive each machine through belts to the pulleys previously mentioned. The motors are operated by 3-phase, 30-cycle current at 440 volts, and specially-designed contactor gear with remote control enables both motors to be started or stopped simultaneously. The

* A Paper read before the Sheffield Branch of the Institute of British Foundrymen.

motor and roller speeds are 860 and 1,100 r.p.m. respectively. The flasks are moved in and out of the spinners by means of hydraulically-operated manipulator-gear. This gear also operates a safety hood which encloses the whole machine whilst spinning proceeds.

The metal is poured into the mould at the spigot end. It is tapped from the cupolas into 3½-ton ladles, of which one is always in place at the cupola, while another is distributing metal to the spinners. Each spinner is provided with its own tilting ladle, which is mounted on a carrier or bogie and which in turn runs on rails on the platform of a weighing machine. Hence, as the iron is poured into the tilting ladle the weight is shown on the weighing-machine dial; therefore the crane driver, who also operates the ladle, merely pours a predetermined quantity of iron equivalent to the weight of the pipe that it is desired to cast. After the tilting ladle is filled the carrier is run forward into the casting position and a signal lamp situated at the opposite or control end of the machine automatically indicates this.

A further signal lamp lights up as soon as the machine is up speed, when these two lights appear the spinner operator tilts the ladle by means of a hydraulic ram. Even distribution of the metal is complete within a few seconds of pouring, and spinning is continued for a period of approximately one minute per in. of dia. By this time solidification has taken place, and the machine is stopped; the flask ejected and a new one takes its place. As the machines are intended to work in pairs, the inlet and outlet gantries of two machines are adjacent to one another; hence, it is normally possible to put down and pick up two flasks at one time, and the 10-ton manipulator cranes, previously mentioned, are arranged for doing this.

Stripping the Castings.

In this way the full flasks are transferred to the cooling gantry which is of sufficient length to enable each flask to occupy 60 to 70 min. in traversing it when the plant is running at full capacity. This ensures that by the time the pipe reaches the stripping station it has lost all colour of heat and therefore cannot take any harm from exposure to the air. It is of interest to note that because of the controlled cooling, the percentage of bent pipes which have been made since the plant started is infinitesimal, and it is quite usual to run for weeks without encountering one.

The pipes are stripped from their moulds by means of hydraulic rams, but as it has been found impossible to carry this out direct, owing to the locking of the sand, a preliminary operation is incorporated. This consists in passing two tubes, through the ends of which compressed air is issuing, through the sand. These tubes are approximately at 4-in. centres and their effect is to remove a longitudinal section of the mould, after which the remainder of the stripping operation becomes comparatively simple.

Because of the dust the preliminary operation is carried out in a closed chamber called the blow-box. The air-jet tubes are mounted on a carriage propelled along a narrow gauge rail track by means of a 5-h.p. motor through reduction gear at a speed of approximately 60 f.p.m. The air is supplied by walking pipes from the shop mains. Adhesion between the carriage wheels and track is sufficiently low to produce slipping should the air tubes meet any abnormal resistance. Manipulating-gear similar to that used in the spinners is again used for transferring the flasks in and out of the blow-box.

When the flasks are in line with the stripper rams which are arranged in pairs, they lie on a tilting table; this table can be tilted to an angle of 70 deg. from the horizontal, hence, when the pipes have been removed and the table tilted the sand falls out to a grating, which latter forms the entrance to the sand reconditioning plant. After stripping, the pipes are conveyed by transfer car to a long gantry running parallel to and partly below the jolting operating platform. From this gantry, they may be diverted to any one of four other gantries situated at right angles by means of specially designed turn-tables. Of these latter gantries three lead to identical finishing units, each consisting of a grinding plant, weighing and proving unit and dipping section.

Grinding Plant.

Slight flashes or other similar surface imperfections which, if present, are generally located at the pipe ends, are removed by means of ordinary pneumatic turbo hand grinders. Internal grinding for the removal of non-metallic matter is effected by means of electrically-driven grinders, the grinding wheel of which is mounted at the end of a long shaft. The pipe while it is being ground is carried on driven roller supports which rotate it in the opposite direction to that of the grinding wheel.

The dust produced by the grinding operation is dealt with by a specially-designed dust-extraction system, which removes it from the pipe at that end remote from the grinder. After the completion of this operation the pipes are inspected, weighed and proved, unless they are of the turned and bored variety, in which case this machining operation is carried out before proving.

Each pipe, whether it is to be inspected by the customer's representative or not, is visually examined, gauged and hydraulically tested to the requisite pressure prescribed by the British Standard Specification by the company's own inspection department. After the pipe has passed inspection, it is moved forward to a coke-fired stove, of the continuous type, the temperature of which, together with that of the tar solution in the adjacent tank, is under pyrometric control.

After the pipe has reached the required temperature in the stove, it is run on to a suspended tray and lowered thereon into a bath of dehydrated tar solution. After sufficient time has elapsed for the coating to set, the pipes are passed out under an open crane gantry, where they are first stencilled, and then loaded for despatch or stock, as the case may be.

Cores.

The cores are made of oil sand on small jolt-squeeze machines of the Osborne type. These machines are fed from overhead bunkers, the sand used being first dried and cooled. It is then delivered in measured batches into small mixers, where the core oil is added in predetermined proportions. These mixers are situated above the moulding machines, so that the sand is fed to these latter by gravity. After the cores are stripped, they are placed on portable racks and transported by means of lifting trucks to one of the eight coke-fired, core-drying stoves. Here they are baked, then removed from the stoves and finally delivered on similar racks to the spinning stations.

Sand-Handling Plant.

It has been mentioned earlier in the Paper that the sand falling from the flasks, immediately after the pipes had been removed from them, passed through a grating, which was the entrance to the sand-reconditioning plant. From this point the sand enters a shaker conveyor and is delivered by it into a cooling drum. This drum is connected to the main dust-extracting system, and the cooling of the sand is effected by the passage of the incoming cool air. Two air jets which are installed at this point for the purpose of desilting the returning sand further assist in the cooling.

From the drum the sand passes to one of two duplicate elevators, which lifts it approximately 60 ft. and delivers it to a vibrating screen, where any foreign matter and sand aggregations are removed; these latter, together with such surplus sand as may have resulted from large additions of new sand or from some irregularity in the working of the plant, are taken by belt conveyor to a bunker outside the building for removal to a dump.

The sand which passes through the screen is received in a storage bunker, whence measured quantities are taken by means of batch hopper and placed in a Smith mixer, similar to that used for making concrete. This batch hopper can also receive new sand *via* another belt conveyor from outside stocks.

The required quantity of new sand (in the neighbourhood of 5 per cent.) is added at this point, together with a measured quantity of clay wash of a known specific gravity. After mixing has proceeded for a sufficient time, the whole charge is transferred to a mill of the Simpson intensive type. This mill operates continuously, by which is meant that sand goes in and out of it continuously, a suitable adjustment of the gates enabling the required degree of bond to be developed during passage through it. Clay wash is prepared by kneading the clay in a plastic condition, and then diluting it in a mixing tank until the required consistency has been obtained. The wash is then transferred to a storage tank, which is embodied in a circulating system.

After leaving the Simpson mill, the sand is delivered to a feeder, which in turn delivers it to an inclined belt. By means of this latter, a horizontal belt, and a tripping belt conveyor, it is delivered into eight cylindrical feeder bins, arranged in pairs above the jolters, and is once more ready for use. As proper sand control is an essential factor for the current functioning of the plant, sand from both mixer and mill is tested for both moisture and strength continually while the plant is working, in addition, permeability tests, specific gravity tests of the clay wash, etc., are taken at frequent intervals during each shift.

Dust-Extraction System.

This system is connected to strippers, blow-boxes, cooling drums, vibrating screen and sand bunkers, etc. The dust is exhausted in the first instance through a cyclone separator, by which the heavier particles are removed and deposited direct into a wagon. The light dust is passed to the bottom of a large vertical scrubber. In this water-flushed grids catch the dust and deposit it at the bottom of the chamber, while comparatively clean air escapes from the top. Pumps draw off the liquid material and discharge it into a separator, from which the sludge flows to settling tanks, and the water is recirculated through the scrubber.

It is of interest to note that the whole of the buildings, and the bulk of the details of the plant itself, were designed by the staff of the Staveley Company, while the fabrication and erection of the building and the manufacture of a large part of the main items of plant was carried out by Messrs. Markham & Company, of Chesterfield, which is a subsidiary company of the Staveley Company.

The Finished Casting.

Now as regards the pipe itself much might be said, but this is a Paper dealing with the plant and not its product. However, there are one or two points which may be of general interest to such a meeting. The first is that the Staveley Sand-spun pipe is of the same external diameter in the body, and has a socket of the same internal dimensions as the British standard pipe. It can, therefore, be used with all British standard straight pipes and specials of the same nominal bores. Due to centrifugal action a casting without gas cavities, blow-holes, and non-metallic inclusions, is virtually guaranteed, and experience up to the present has amply confirmed this. The tensile strength of the metal

(*Concluded on page* 309.)

The Production and Application of Manganese Steel in Australia.*

By D. Clark and J. Coutts, Newcastle, N.S.W., Australia.

To Sir Robert Hadfield belongs the honour of having instituted the initial research in the field of alloy steels, and his discovery of manganese steel represents an event of outstanding importance in the progress of engineering. Without in any way overstressing his claim, he might also be regarded as having pioneered the effort to lift the art of heat-treatment of steel out of the region of empirics by focusing the searchlight of scientific reasoning on its problems. It is strange indeed that the product of this early research should have resulted in evolving a steel unique in its way, and little imagination is required to visualise the immense amount of work that was necessary before its marketing as castings or in the form of rolled and forged products became an accomplished fact. This achievement could only have been made possible by the exercise of painstaking effort and a high courage.

Other investigators, earlier or contemporary, undoubtedly had inquired into the effect of various alloying elements in steel, but their interest would appear to have ebbed in finding themselves up against apparent anomalies and difficulties. The inventor's experiments commenced in the year 1882, and two years later came the culmination of his work when patents were granted for what is now known as "Hadfield's manganese steel." That it has been of immense service to the engineering world is undoubted, and its true value may be gauged from the fact that, despite the ever-expanding ranges of alloy steels, no steel has supplanted the original manganese steel in those particular applications for which it has been found peculiarly suited.

Amongst all the alloy-steels known, there is perhaps none the quality of which is less affected for most purposes by the process selected for its manufacture. If one wished to produce the highest quality of most other alloy or high-grade carbon steels, there are only two processes that would be considered, namely, the crucible and the electric furnace, provided these processes were capable of supplying the quantity required for a single purpose, while the last choice would probably be the Bessemer. During the early years succeeding its discovery, manganese steel was produced mainly by the Bessemer and Tropenas processes, and although the tendency to-day is to utilise the electric and open-hearth plants in increasing measure, it is very doubtful whether the average product obtained gives much if any better service than that made in converters, when the steel was first introduced. Foundry technique, however, has and still is being improved, and it may be fairly claimed (in so far as the part the foundryman plays) that the present-day casting is a more workmanlike job.

Life of Manganese Steel.

In Australia, manganese steel castings are used for a variety of purposes, such as stamp mills, railway points and crossings, liners for tube mills, brick and tile machinery, gears and chain sprockets, crusher, dredger and excavator parts, shields for lifting magnets, etc. As is well known, the successful application of austenitic manganese steel depends chiefly on the conditions under which it operates, and it is generally accepted that satisfactory service may be expected only where percussive action predominates. This premise, however, is not strictly accurate, since an equal efficiency may be obtained by rolling action, the degree depending upon the load carried. In the case of rolled rails or cast points and crossings, the life of manganese steel compared with carbon steel of the grade generally used for these purposes has been proved to be not less than 4 to 1, and may reach 9 to 1. In castings with design showing abrupt changes of section, and which may be subjected to shocks of any magnitude, care is necessary to see that they are adequately supported in position practically over their entire area, because the characteristically low limit of elasticity which manganese steel exhibits may cause it to bend readily where there is semblance of an overhang, or fracture prematurely at a sharp-angled intersection. Wherever possible, therefore, all sharp corners should be rigidly guarded against.

Steel Making.

Manganese steel containing, say, 12.5 to 13.5 per cent. of manganese has a melting point of about 1,345 deg. C., while that of 1 per cent. carbon steel is 1,435 deg. C. It thus has a lower melting point than plain steel of equivalent carbon. It has a high degree of fluidity, and in good practice advantage is taken of this to keep the temperature low, not only because of the erosive effect that increasing temperature has on the furnace lining, ladles and moulds, but also because the higher the temperature the greater is the loss of manganese alloy. Similarly, the duration of the pouring period also has an effect on manganese efficiency. Illustrating this, the data of Table I are submitted showing the erosive effect of manganese steel on the ladle lining and moulds, evidenced by the progressive increase in silicon and the part that time plays in the loss of manganese during pouring. It might be stated that the casting temperature of this particular heat was higher than normal.

TABLE I.—*Errosive Effect of Manganese Steel on Ladle Lining and Moulds*

	C. Per cent.	Si. Per cent.	Mn. Per cent.	P. Per cent.	S. Per cent.
2.05 p.m. furnace sample ..	1.48	0.12	14.15	0.047	0.011
2.15 p.m. furnace tapped ..	—	—	—	—	—
2.19 p.m. sample taken ..	1.46	0.22	13.47	0.049	0.005
2.33 p.m. sample taken	1.42	0.59	12.21	0.049	0.001
2.43 p.m. sample taken ..	1.45	0.79	11.74	0.049	0.002

Two points emerge from these data:—(1) the desirability of keeping the temperature reasonably low so as to minimise the attack on the siliceous linings and moulds, and (2) the necessity for using the steel quickly so as to ensure some degree of uniformity in the manganese content from the beginning to the end of the pour. It is characteristic of manganese steel that, although the manganese in the samples quoted in Table I vary, there was no observable difference in their physical properties after suitable heat-treatment. A steel of excellent quality can be obtained from the basic electric furnace by using an all-manganese scrap charge, which has the virtue that only a small amount of ferro-manganese is necessary to bring the bath to the required analysis. Apart from the economic aspect, this feature is of importance when it is considered that the ferro-manganese additions are made necessarily at a late stage of the process, and that the larger the addition the greater is the drop in the bath temperature—which takes time and care to readjust.

In the converter process, the ferro-manganese is added in the fluid condition to the blown iron in the ladle, or *vice-versa*. Consequently, the oxidation losses are much higher than in the electric furnace, when the atmosphere is for the most part reducing, except in the vicinity of the charging doors. Even in those areas, however, something approaching reducing conditions can be obtained if the doors are kept reasonably tight to prevent the infiltration of excess air. In those Australian plants, where steel is made by the electric process, the type of furnace in general use is the Héroult. Where the converter is the steel-making unit employed, the side-blown Tropenas type is used in conjunction with a crucible furnace for melting the ferro-manganese.

In running a typical heat, the converter charge is blown down in a manner similar to that followed by the production of soft carbon steel, and a silicon addition to give 0.15 per cent. of that element in the finished manganese steel is made to the ladle. After standing five minutes, a measured volume of blown metal is added to the molten ferro-manganese, which has previously been transferred from the crucibles to a graduated mixing ladle. The metal is then skimmed and lightly dusted with silica sand. Small castings are poured from hand shanks, while those of heavier section are lip-poured from the crane-ladle as the metal progressively cools. Steel of very consistent chemical contents is produced by this method of manufacture. Sixteen heats made recently for one type of casting showed the following variations:—

	Maximum.	Minimum.	Average.
Manganese, per cent.	13.0	11.8	12.3
Carbon, per cent. ..	1.32	1.28	1.3

Variations in chemical composition are sometimes specified for particular purposes, and one company making steel by the converted process has been called upon to produce manganese steel with a carbon content as low as 0.75 per cent. How these castings compared with those of the traditional analysis is not yet known.

When the method of casting is by way of a bottom-pouring ladle, the erosive effect is such that the casting action on the nozzle may be very severe when the fireclay type is used. This not only tends toward reduced metal recovery at times due to leaking stoppers, but it may also affect the quality of the castings. Therefore, when using fireclay nozzles it is necessary to select one with the best surface obtainable and to ensure that with the stopper a perfect seal is obtained. While the latter precautions are helpful, the substitution of magnesite nozzles in place of fireclay results in greater efficiency, as it is found that the cutting action of manganese steel on this nozzle is negligible as compared with that on the fireclay type.

Analysis.

Until the introduction of the super-high-speed steels, the drilling of manganese steel samples for analysis alone was a problem. A common practice is to heat-treat the test block at a low temperature, say, about 450 deg. C., and drill when cold. Greater ease of drilling is obtained when an ordinary high-speed drill is used, by heating the sample uniformly, then drilling hot so that blue-tinted cuttings are obtained. An expressed doubt that such drillings are not capable of giving a true analysis was refuted on investigation. No variation whatever was observable on comparative analysis made between the slightly oxidised and the usual bright drillings.

Hadfield's original specification provided for carbon 0.95 to 1.50 per cent. and manganese 10.0 to 15 per cent. Generally, the carbon-manganese ratio of approximately 1 to 10 is still preserved. Lately, however, there is a tendency to lower the carbon to around 0.90 per cent., keeping the manganese at 12.00 per cent. minimum. This

* A Paper presented on behalf of the Bureau of Steel Manufacturers of Australia to the American Foundrymen's Association.

involves the provision of a lower-carbon ferro-manganese alloy than is habitually used. It is claimed that superior service is obtained from castings of the lower carbon-content, although the authors have no reliable data to confirm or deny this assertion. Assuming, however, that there is no virtue in the lower-carbon analysis so far as wear is concerned (and the authors are frankly sceptical), greater freedom from contraction cracks or pulls may result. In other words, it may be found that the lower carbon content shows the steel to have reduced the tendency to brittleness while cooling in the mould after casting, more than when the 1 to 10 ratio or thereabouts is observed. Viewed from that angle, this analysis may possess economic manufacturing advantages.

Effect of Phosphorus.

With regard to the effect of phosphorus on the properties of manganese steel, it is noticed that some users' specifications limit this element to a maximum of 0.06 per cent. While the question of keeping the phosphorus to reasonable limits on alloy steels may be accepted in a general sense, the same necessity does not arise in respect to manganese steel. Some of the best manganese steel of which there are records contains up to 0.12 per cent. phosphorus. Again, it is suggested that it is desirable to have the manganese around 14 per cent. rather than 10 per cent. Considering that the ferro-manganese itself contains approximately 0.25 per cent. of phosphorus, obviously it is impossible consistently to fulfill both conditions on an ordinary manufacturing basis. The tentative specification recently adopted by the American Society for Testing Materials for austenitic manganese castings would appear to have been based on experience and with due regard for the interests of manufacturer and user alike. This specification is considered sound, and provides for: C, 1.00 to 1.40; Mn, 10.00 to 14.00; P, not over 0.10 per cent.

Heat-Treatment.

Bearing in mind its brittle nature as cast and until actually quenched, it is obvious that not only should the heat-treatment be carefully controlled, but that the castings must be carefully handled during charging and withdrawal from the furnace. Due to its well-known low order of heat conductivity, and also to avoid overheating the lighter sections, it is necessary to heat slowly (100 deg. C. per hr. is a suitable rate of heating), until a medium cherry-red colour is attained, say, at 750 deg. C. Soak at this temperature to ensure uniformity throughout the charge, then accelerate the heat-input until the desired temperature is reached. On account of the facility with which surface decarburisation takes place, it is not desirable to prolong the final soaking period beyond that required for equalisation of the temperature throughout, because a decarburised surface induces skin brittleness.

Some recent work by Svechnicov indicates that the maximum tenacity and minimum loss by abrasion is obtained by heating to 1,150 deg. C. This temperature seems excessive, and, while good properties may be secured on certain casts experimentally treated where it is possible to grind off the resultant embrittled skin, it is neither desirable nor practicable to do this on a production basis. The correct final toughening temperature to bring the best results depends to a large extent on the temperature at casting, and on the speed of pouring. When the casting-temperature is low and the speed of pouring high, the temperature limits producing the ideal condition lie between 1,000 and 1,040 deg. C. It is only when the casting temperature is excessive or the carbon is too high in relation to the manganese that it is necessary to exceed the top limit given.

In quenching, it is highly desirable to extract the heat as rapidly as possible, and to ensure this a copious supply of cold water should be constantly flowing into the tank and the hot water drawn off. It is well known that in reheating a toughened sample the steel becomes brittle at around 400 deg. C. Therefore, to ensure that the austenitic condition is retained completely, it is necessary to quench to a temperature definitely below this. Considering the question of mass, there is a limit in thickness beyond which manganese steel should not be used as castings, particularly if subjected to heavy impact or bending moment in service. Five inches is suggested as the absolute maximum section that should be used, and only then under particularly favourable circumstances. For general purposes, the thickness should not exceed 3 in.

Bearing in mind its characteristic resistance to the absorption of heat, and proceeding in the opposite direction, it can be understood that the complete retention of the austenitic condition is dependent on the speed at which the heat is extracted. As this, in turn, is dictated in part by the mass, it provides the reason why there is a limiting thickness which must be observed if the steel is to be presented in its best condition. It doubtless is well known that manganese steel fails badly unless it is operating under conditions that will produce a rapid increase of hardness on the working face, or faces, which in turn determines its quality of resistance to abrasion. However, if means could be devised of supplying castings to suit all sorts of conditions, then the applications of manganese steel could be widely extended.

Purpose and Use of Alloys.

Apart from increasing the surface hardness by mechanical means, the only method offering a degree of success is to introduce an alloy which would increase the initial hardness without seriously interfering with the characteristically high resistance of the steel to impact. An alloy offering possibilities, and which at the same time would not have a great effect on the cost (which is an all-important factor), is chromium.

Table II.—*Analysis of Heats for Work-Hardening Tests*

Heat	C. Per cent.	Si. Per cent.	Mn. Per cent.	S. Per cent.	P. Per cent.
A	1.31	0.10	12.73	0.010	0.061
B	1.15	0.36	12.07	0.012	0.050
C	1.13	0.40	11.40	0.005	0.052
D	1.21	0.34	12.06	0.002	0.058
E	1.12	0.31	10.70	0.003	0.045
F	0.97	0.25	10.27	0.005	0.059
G	1.20	0.30	11.73	0.008	0.046

One of the authors has done a limited amount of work along those lines, and he has found that an addition of 2 per cent. chromium to a normal analysis, and water toughening in the usual manner, increases the initial hardness from approximately 200 Brinell to approximately 286. At the same time, the capacity to further increased hardness by cold work was not affected. It would appear, therefore, that there are possibilities, working carefully along somewhat similar lines, which will enable manganese steel to be used under circumstances where hitherto it has had only qualified success.

Work-Hardening Capacity.

In order to test the hardening capacity of a number of casts of varying analysis, several experimental tests were carried out. Seven heats were selected of the analysis shown in Table II. A sample from each heat was taken and lightly hammered with a hand hammer for definite periods of time, and Brinell tested at each stage. In the case of Sample G, the hammer blows were heavier than with the others. The results obtained are shown in Table III. While this method of testing the work-hardening capacity is somewhat crude, yet an approximate indication is obtained of the qualities of one cast or of one composition against another. Reviewing the results, while it is unfortunate that none of the casts used shows a manganese content exceeding 12.73 per cent., the indications are definitely there that the lower manganese heats do not suffer by comparison with the higher.

A further work-hardening test was carried out by one of the writers using a pneumatic riveting hammer, operating a small tool having a working face of 1 × ¾ in. A bar of normal manganese steel, 1 in. wide by ½ in. thick, was selected and subjected to hammering for periods varying from 10 to 60 secs. It was found that the Brinell hardness increased 100 per cent. after 40 secs. only, on a 1-in. length of bar. This is a method which might readily be applied by manufacturers when selling castings to operate under conditions where the rate of increase in surface hardness is low.

It is generally accepted that the increase in hardness of manganese steel due to work arises from a precipitation of the carbides from the austenitic solution. In order to verify this, one of the Table III samples (C) was selected and a section cut from the work-hardened area. This section was polished at right angles to the hammered face and examined along the work-hardened edge. Viewed at 100 magnifications, no trace of free carbide was observable, but there was exhibited an apparent crumbling of the austenitic grains. As already shown, this sample was lightly hammered for 65 min. only. It may be that continued hammering for an extended period will cause a carbide precipitation, although this has yet to be demonstrated.

Design of Manganese Castings.

The difficulties surrounding the manufacture of manganese steel castings have not been widely discussed, and success has only been achieved by experience. Design plays an important part in the production of a sound casting, which is the first consideration. Therefore, the engineer responsible for the design should be familiar with the properties of manganese steel. He must guard against abrupt changes in metal section, and, where possible, provide for uniform metal thicknesses throughout the casting. Ample brackets and fillets of correct proportions are contributing factors. Cored holes, etc., must be rounded to resist the stresses set up by high shrinkage. When small holes are desired in thick sections, mild-steel insets (which are later bored out) or pipes replace sand cores, and mild-steel bushings are set in hubs or bosses where a machined finish is necessary.

Table III.—*Brinell Hardness of Samples of Analyses as shown in Table II.*

Sample.	Normal.	Time hammered, minutes 15	25	30	40	50	55	65
A	202	247	387	444	477	477	495	532
B	187	235	387	418	477	495	512	555
C	202	247	364	402	495	512	512	532
D	192	235	351	387	444	495	532	532
E	179	228	364	387	444	477	495	512
F	217	247	418	444	495	512	532	578
G*	202	332	387	—	532	—	—	—

* Subjected to heavier hammer blows than other samples.

Importance of Correct Risering.

Not the least important factor in the successful production of manganese steel castings is the shape and position of the risers. Until comparatively recently, in jobbing shops at least, the

type and placing of risers was more or less the whim of the individual moulder, who often was left to his own devices. The results of this policy often were to be seen in unsound and ineffectively fed castings, particularly in those steels of inherent high contraction. It is now recognised, however, and rightly so, that there is no part of the moulder's job more important than fixing the dimensions and position of the risers, and greater consideration now is given this phase than ever before.

In the manufacture of ingots, to ensure the maximum freedom from shrinkage cavities, the large end of the hot top always is placed at the bottom. Yet how many times have we seen risers with the smallest dimensions at the point of entry? There are instances, of course, when this may be unavoidable—such as in the case of very light sections; but generally, necked risers should never be permitted, as only a small percentage of the metal can find its way through the bottle-neck for feeding purposes. Even in the case of light sections it often is preferable to ensure effective feeding by making the riser at the base wider than the section, thus incurring extra expense of removal rather than risking the possibility of an unsound casting.

An adequate riser does not necessarily mean less effective recovery of finished castings. On the contrary, it may mean more in the final analysis, because it often is possible to cut down actual weight of a well-designed riser due to greater efficiency. In dealing with manganese steel or any similar piping steel, it is necessary to increase the height of the riser beyond that required for mild steel. In other respects the risers may be the same.

There is another aspect of the riser problem to which insufficient attention is given, namely, the question of using them hot. It is obvious that the effectiveness of any riser is governed to some extent by its temperature at the time of pouring; and no riser, however well designed, can be 100 per cent. efficient if it is cold. The foundryman seeking the best results and the highest recovery will keep his risers hot and never place them on the job until the last moment.

Preparation of Moulds.

Highly refractory, free venting, naturally bonded sands are generally used. In dry-sand work, provision for metal contraction is made by digging out pockets and filling with old sand at points where excessive resistance may be set up. Such sands produce satisfactory castings, provided the teeming temperature of the metal and gating of the mould is properly controlled. Internal chilling is resorted to only in extreme cases. When internal chilling is considered necessary, crimped or waved $\frac{1}{8}$-in. or $\frac{1}{4}$-in. manganese-steel wire is useful, because it does not present the resistance to contraction of an equivalent weight of straight wire in the event that the chilling is overdone. Experience has shown that best results, from the standpoint of appearance and structure of the steel, are obtained by teeming at the lowest temperature relative to the section of the casting, and admitting the steel at as many points as are permissible. This ensures a more uniform temperature gradient throughout the cooling metal.

Fettling of Manganese-Steel Castings.

The cutting of risers from manganese steel castings often presents difficulties. As is well known, manganese steel in the "as-cast" state is very brittle, due to the arrangement of free cementite about the grain boundaries, and often a well-directed blow with a hammer is sufficient to sever a comparatively large head. This method, however, is seldom practised on account of the danger of fracturing the casting itself. It is a debatable point whether castings should be removed from the sand, roughly fettled and then placed in the furnace while still hot, or allowed to cool slowly in the sand before proceeding with the subsequent treatment. Generally, however, the latter procedure is followed, although in either case it is not necessary to remove thoroughly all the adhering sand.

The removal of risers, runners, etc., by the use of the oxy-acetylene torch calls for extreme care, because of the danger of local overheating, setting up stresses which may result in cracking the castings. The following methods have been tried to overcome this difficulty:—(1) Castings are first heated in a furnace or upon an open fire; (2) castings are immersed in water to the line of the proposed cut, and (3) the cut is followed by a stream of water delivered by a fishtail nozzle. This last method finds general favour, being easily applied, flexible and efficient.

Strength of Cast Steel at High Temperatures.

The increasing use of alloy-steel castings for parts of machinery subjected to high temperatures gives importance to the carrying out of systematic investigation of the properties under such conditions. A report of tests on specially cast specimens from room temperature up to a temperature of 500 deg. C., carried out at the Foundry Institute of the Technical College at Aix-la-Chapelle, is given by K. H. MÜLLER and E. PIWOWARSKY in "Archiv für das Eisenhüttenwesen" for March of this year. The composition and heat-treatment of the different steels tested are given in Table I. These were prepared in a 2-ton Héroult furnace, Nos. 57, 101, 182, 715 and 1,329, with two slags in the usual manner and the remainder with only one slag, since the most of the alloying ingredients were already present in the scrap. The test-pieces were cast singly in green-sand moulds, horizontally with a large sinking head 80 mm. deep.

TABLE I.—*Composition and Heat-Treatment of the Cast Steels investigated.*

Steel No.	Chemical composition in percentages. C.	Si.	Mn.	P.	Other elements.*	Annealing temperature, deg. C.
1,329 ..	0.12	0.70	0.72	0.036	—	930
715 ..	0.32	0.38	0.70	0.041	—	850
57 ..	0.36	0.58	0.83	0.040	—	850
101 ..	0.18	0.47	0.87	0.042	2.21 per cent. Cr	880 †
112 ..	0.69	0.42	0.89	0.040	2.16 per cent. Cr, 1.04 per cent. W ..	800
182 ..	0.36	0.42	1.96	0.046	—	850
1,339 ..	0.31	0.43	0.64	—	1.24 per cent. Cr, 2.98 per cent. Ni	930
1,682 ..	0.40	0.47	0.72	0.017	2.36 per cent. Cr, 0.40 per cent. Mo, 0.12 per cent. V	930‡

* Only traces of sulphur. † Cooled in the furnace. ‡ Air-hardened, tempered for 2 hrs. at 600 deg. C.

These steels were tested at room temperature, 100 deg. C., 200 deg. C., 300 deg. C., 400 deg. C., and 500 deg. C., with regard to impact value (Charpy, 4 mm. round notch, striking energy of hammer 75 mkg.), hardness (Wüst-Bardenheuer falling ball), tensile strength and creep resistance. It was found that the tensile and creep strengths and the hardness were only slightly raised by increasing the carbon and by addition of manganese, but considerably so by the use of chromium, especially in combination with tungsten or still better with nickel. The impact value varied approximately in the reverse direction. It was not possible to determine any definite relationship between the impact value and the hardness.

The tensile tests were made on pieces 10 mm. dia. with a gauge length of 50 mm. They were held at the testing temperature for half an hour after heating up, to ensure thorough soaking. The temperatures were measured at both ends and at the middle, very uniform heating being obtained. The ultimate strength was determined at a rate of extension of 15 mm. per min. As a general rule it only fell slightly between room temperature and 400 deg. C., in the case of Nos. 57 and 182 actually increasing to a small extent between 200 deg. C. and 400 deg. C., whilst there was a sharp fall with all the steels between 400 deg. C. and 500 deg. C. Unfortunately the results for No. 1,682 were completely irregular, possibly due to defects in the castings, such as blowholes, and in the heat-treatment. The values of the ultimate strengths scaled from a diagram are given in Table II:—

TABLE II.—*Strength of Cast Steel at High Temperatures.*

Steel No.	Kg./sq. mm. Room temperature.	At 400 deg. C.	At 500 deg. C.
1,339 ..	84.0	73.0	52.5
182 ..	73.0	66.0	47.0
112 ..	70.5	68.0	49.0
1,682 ..	64.0	67.0	37.0
57 ..	62.0	57.0	33.0
715 ..	53.0	49.0	31.0
1,329 ..	46.0	34.5	26.5

The elongation at fracture fluctuated very considerably, there being no definite connection with the temperature, except that practically in every case it was low at 400 deg. C., from which it increased to a greater or less extent at 500 deg. C., the increase in the case of No. 1,339 being from 7.2 to 14.2 per cent., while for No. 112 it was from 14 to 29 per cent.

The creep stress was determined by the short-time method proposed by Pomp and Enders, as the stress which gave a creep rate of 0.003 per cent. per hr. between the 10th and 15th hrs. under load. Special care was taken to keep the furnace temperature uniform, since quite small variations exercised a very great influence on the curves of extension. The test-pieces were heated in a salt bath in order to ensure uniform temperature distribution within them. Since at lower temperatures this method of test gives values which are in excess of those shown to be permissible by the ordinary quick tensile test, these values are not given in the report, from a diagram in which the details in Table III have been scaled:—

TABLE III.—*Creep Stress.*

Steel No.	Creep stress, kg./sq. mm. At 400 deg. C.	At 500 deg. C.
1,339	33.5	14.3
1,682	16.0	16.6
112	23.3	6.5
1,329	11.0	7.5
182	18.0	5.0
101	15.0	5.0
57	14.0	5.0
715	9.0	5.8

The values given for No. 1,682 show the same irregularity referred to in connection with the determination of the ultimate stress.

Grantex Rollers.—A firm in the City is anxious to learn who makes Grantex cast-iron rollers.

Lattice Spacings of Iron-Aluminium Alloys.*

By A. J. Bradley and A. H. Jay.

Summary.

(1) The lattice spacing of the range of FeAl alloys between 0 and 33 per cent. aluminium by weight was determined by the powder method. A new technique was employed in order to obtain a high degree of accuracy. The results were compared with those previously obtained for the structure changes.

(2) Both annealed and quenched alloys with from 0 to 10 per cent. of aluminium have a random atomic distribution and show a linear increase in lattice spacing.

(3) Annealed alloys with from 10 to 17 per cent. of aluminium have a constant value for the lattice spacing. The Fe_3Al type of structure exists in this region, emerging gradually from the random arrangement. The lattice spacing of annealed alloys drops slightly from 17 to 20 per cent. aluminium, and the structure gradually changes to the FeAl type.

(4) Quenched alloys differ from annealed alloys beyond 10 per cent. aluminium. The lattice spacing increases right up to 14 per cent. aluminium, but more slowly than before, the distribution remaining random. There is a sudden

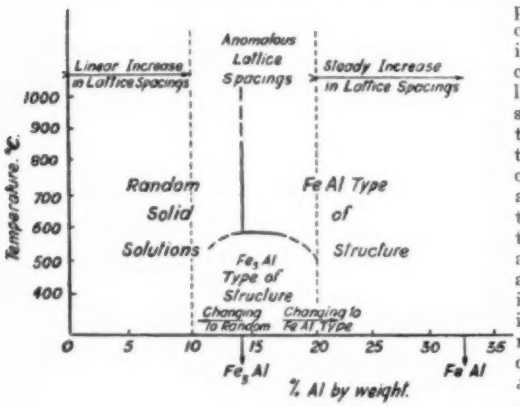


Fig. 1.

fall in lattice spacing at 14 per cent., which corresponds to a change from the random state to the FeAl type of structure. The lattice spacing oscillates slightly in value from 14 to 20 per cent.

(5) Both annealed and quenched alloys have the FeAl type of structure from 20 per cent. aluminium onwards, but the lattice spacings differ according to the previous heat-treatment. Alloys quenched from 700 deg. C. obey the linear law. Alloys quenched from 600 deg. C. and annealed alloys show a less uniform increase in spacing.

(6) It is suggested that some of the peculiarities in the lattice spacings between 10 and 20 per cent. aluminium may be due to a change in the valency of the iron atoms; these are probably null-valent between FeAl and the approximate composition Fe_3Al, but with less aluminium the valency of the iron atoms is likely to increase.

Conclusions.

The investigation of lattice spacings described in the present Paper shows that the FeAl alloys in the range 0 to 32.6 per cent. aluminium by weight behave in an extremely complicated manner. The sudden break in the lattice spacing of the quenched alloys at 14 per cent. aluminium, coupled with a sudden change in structure, suggests a phase change at this point. This is indicated in the diagram, Fig. 1, by a vertical line. Perhaps a two-phase region might have been expected to occur between the quenched alloys with random distribution and those with the FeAl type of structure, but the X-ray data give no evidence for the existence of such a region.

The annealed alloys present a more difficult problem. Three types of structure exist, but there is no evidence (metallurgical or X-ray) for a phase boundary at a definite composition. Clearly there is a break in the lattice spacing curve at about 10 per cent. aluminium, and apparently there is a further break at about 17 per cent. and again at about 20 per cent., but it would be somewhat arbitrary to fix the boundaries of the Fe_3Al phase at these points since the transition to the random structure on the one hand and the FeAl structure on the other is a continuous process.

On neither side of the Fe_3Al region is there any evidence for the co-existence of two phases. Microsections of all alloys, from those containing only a small amount of aluminium right up to FeAl, reveal only the existence of large homogeneous crystals. The boundary between the quenched alloys of the FeAl type and annealed alloys of the Fe_3Al type of the same composition is included in Fig. 1. The precise position of this boundary is somewhat arbitrary, and the diagram is only intended to suggest the fact that a transformation does occur at some temperature below 600 deg. C.

The diagram suggests the existence of three phases. This must not be interpreted in any conventional sense, since in annealed alloys there is a gradual transition and not a sharply-marked change. The diagram also shows two vertical lines, which indicate breaks in the lattice-spacing curves. To the left of the first break the alloys obey Vegard's law, which states that the lattice spacing increases linearly with the composition. Vegard's law is also obeyed by alloys quenched from 700 deg. C. in the range to the right of the second vertical line. At intermediate compositions there are a number of anomalies. Here Vegard's law is not even approximately true, the lattice spacings showing peculiar fluctuations. It has been suggested in the previous paragraph that these anomalies may be due to a change in the state of valency of the iron atoms, beginning at 10 per cent. aluminium and ending at about 20 per cent.

It must be emphasised that the structure changes and the valency changes do not necessarily coincide. Thus, the random distribution continues for quenched alloys beyond the point where Vegard's law holds good. The final value of the lattice spacing appears to be influenced by the interplay of two effects: (*a*) the state of ionisation of the iron atoms, and (*b*) the type of atomic distribution. Vegard's law appears only to hold good when the state of ionisation of the iron atoms is uninfluenced by the concentration of the aluminium atoms and the type of packing does not change. The effect of the difference in packing is not great, as can be seen from the comparatively small drop between the lattice spacing of the random arrangement and that of the FeAl type for quenched alloys at 14 per cent. aluminium. This effect, which amounts to about 1 part in 700, is easily accounted for by the larger atomic radius of aluminium compared with that of iron. In the FeAl structure the closest contact is made between iron and aluminium atoms and not between two aluminium atoms, as is possible in the random state.

* From a Paper read before the Spring Meeting of the Iron and Steel Institute.

A cement for rubber belts can be made from 16 parts gutta percha, 4 parts india rubber, 2 parts pitch, 1 part linseed oil. Melt together and apply hot.

The Hull City Council, on May 10, approved new proposals for the construction of a pedestrian and vehicular bridge over the River Humber. The whole cost of the bridge will be met by the issue of £2,000,000 5 per cent. debentures. The Hull and District Chamber of Trade is opposed to the new scheme.

Properties of Some Silico-Manganese Steels.*

By G. Burns.

Summary and Conclusions.

The effect of silicon and of manganese on the mechanical properties of steels containing 0.36 to 0.54 per cent. of carbon has been determined.

(1) *Normalised Steels Suitable for Structural Purposes.*—Both silicon and manganese raise the elastic limit, yield point and maximum load, and lower the elongation and impact figure. In the presence of upwards of 1 per cent. of manganese, silicon in excess of 1 per cent. is specially detrimental to the ductility and impact value. Silicon has a slight effect in raising the yield ratio, but the properties of the steels are largely accounted for by the carbon and manganese contents. All the steels examined (carbon exceeding 0.36 per cent.) suffer from the disadvantage of high-carbon high-tensile steels, and it is doubtful if any of them show properties which could not be equalled or exceeded in a carbon-manganese steel of the usual silicon content.

(2) *Heat-treated Steels for Constructional Purposes.*—In the oil-hardened and tempered condition, both manganese and silicon raise the tensile strength and lower the ductility and impact value of the steel. Manganese has a greater effect than silicon, and also causes a greater increase in the value of the yield ratio. In general, silico-manganese steels require a high hardening temperature to develop their best mechanical properties, though there are indications that as the silicon content increases, the actual benefit derived from the high hardening temperature becomes less. This is connected with the fact that a slight reduction in the rate of cooling through the critical range has a marked effect in reducing the efficiency of the hardening of high-silicon steel. Silicon steels containing less than 1.5 per cent. of manganese are susceptible to mass effect, and if a high yield ratio is required or sections greater than about 2 in. dia. are to be treated, water-quenching should be employed. It is desirable to limit the carbon content to a maximum of 0.45 per cent. in the water-quenched steels. In counteracting mass effect an increase in the manganese content is much more effective than an increase in the silicon content.

(3) *Heat-treated Steels for Springs.*—Steels lying at the extreme limits of the usual specification for silico-manganese spring steels have been investigated. A low manganese content is always associated with a low-yield ratio, and a high manganese content with a high-yield ratio. Fatigue tests carried out on three steels in the oil-hardened and tempered condition show that a steel with a high-silicon, low-manganese content and a low-yield ratio is less affected by surface irregularities than are two steels with higher manganese contents and higher yield ratios. On the other hand, the steel with a low manganese content is much more affected by surface conditions due to heat-treatment than are steels higher in manganese and lower in silicon.

An increase in the silicon content leads to an increased tendency to surface decarburisation, while an increase in the manganese content has the opposite effect. These two elements affect surface decarburisation in a direction opposite to their effect on the tendency of a steel to scaling.

The partnership between Messrs. Gilbert Peacock, H. J. Harratt and William Payne, carrying on business at Market Street, Rugby, as the Rugby Aluminium Castings Company, has been dissolved by mutual consent so far as concerns Messrs. Harratt and Payne, who retire from the firm.

* From a Paper read before the Spring Meeting of the Iron and Steel Institute.

A Successful Year.

PROGRESS OF MIDDLESBROUGH FOUNDRY ACTIVITIES.

The annual meeting of the Middlesbrough Branch of the Institute of British Foundrymen was held in the Cleveland Technical Institute, Middlesbrough, on Friday, April 8, the retiring President, Mr. A. G. Harrison, being in the chair.

MR. F. A. HARPER, the hon. secretary, in his annual report, at the outset recalled that in 1931 the Middlesbrough Branch completed a most successful year, the main features including a National Convention, a big increase in membership, 20 per cent. better attendance at meetings, nearly £25 increase in funds, and the awarding of the third diploma in five years. These record-breaking sessions were all very well in their way, but they made the secretary's report for the following year appear to be mild by comparison. He could say, however, that the Branch had fully maintained its membership, also the attendance level, and their funds were still in a very satisfactory state. He then reviewed the Papers submitted during the Session, and remarked that the sixth (and final) Paper was the only one given by a non-member, Mr. F. Swift, of the Darlington Forge Company, Limited, on "Mammoth Cunarder Castings." This was an extraordinary meeting. It was attended by nearly 400 foundrymen, and taxed this large hall to its full capacity, the members and visitors were able to follow slide after slide illustrating fully the process of moulding and pouring the heaviest, and one of the most remarkable sets of steel castings ever made. The Branch were greatly indebted to Mr. Swift for his splendid Paper.

The Syllabus Committee has no easy task in providing 6 or 7 Papers of the best type during the next few months, and he urged Middlesbrough members to come forward voluntarily with Papers on *local* conditions, the value of which could not be too strongly emphasised. A good Paper did not necessarily call for the elaborate wording of an after-dinner speaker—what *was* wanted is more of the "potted wisdom" of the after-*meeting* speaker, which usually was unpublished. No doubt the walls and staircases of this building were in possession of facts and figures of the utmost importance to the foundry world.

The Middlesbrough Branch of the Institute of British Foundrymen was *definitely sound*, and was performing well and truly its main function—that of bringing together at regular intervals all grades of foundrymen for the interchanging of ideas to the individual good, and the general advancement of the industry. Were it not for the Institute of British Foundrymen, which has already been responsible for bringing 50 Papers to Middlesbrough, he questioned whether local foundrymen would have had the opportunity of hearing more than two or three Papers with any bearing upon foundry work.

In conclusion, he expressed his warmest thanks to the Financial Secretary for his splendid co-operation, to the President for his great interest and assistance, to the Council for the very able handling of affairs, to the receptionists for their very valuable work at the door, to the directors of the Cleveland Institute for the continued use of this building, to the various speakers for an excellent set of Papers, to the lanternist for his indispensable services, and to *all* those to whom he had turned for advice and help, which had always been forthcoming.

The HON. FINANCIAL SECRETARY (Mr. T. E. Bashford) reported a balance in hand of £15 10s. 7d., and the report and balance-sheet were unanimously adopted.

The CHAIRMAN announced that the Council had unanimously recommended Mr. S. P. Thorpe, foundry manager to Messrs. P. Kinnell & Company, Limited, heating and ventilation engineers of London and Thornaby, for the position of President during the coming session. MR. N. D. RIDSDALE proposed Mr. Thorpe's election, and, in seconding, MR. F. P. WILSON, J.P., said Mr. Thorpe had already done a great deal for the Branch.

Mr. Thorpe's election was carried unanimously, and in reply the newly-elected President said he would use his best endeavours to promote the progress and influence of the Branch and Institute.

The other officers elected were:—*Senior Vice-President*, Mr. J. E. Mercer; *Junior Vice-President*, Mr. J. Hackwood; *Hon. Secretary*, Mr. F. A. Harper; *Hon. Financial Secretary*, Mr. T. E. Bashford; *Council Members*, Messrs. C. B. McCusker, R. J. H. Ritchie, J. K. Smithson and J. E. Ramsay.

A vote of thanks was accorded to the officials for their services during the past year, on the proposal of MR. F. P. WILSON, who said they had been well served in every office from President downwards.

Cupola Economics.

A short address on Cupola Economics was given by MR. N. D. RIDSDALE, who said: Much is heard to-day about economy and how to stem unemployment, but we are often blind as to some fairly obvious ways of introducing economies, and there is no doubt that some of the unemployment is the result of our inability to adapt ourselves to changed conditions. More often than not people are slow to apply the results of proved research, and what we need in many cases is to apply what is known by the minority rather than to spend money on new research.

The cupola is perhaps the Cinderella of the foundry, and is certainly one of the most important units, and though much has been talked about improving melting conditions, the fact remains that there is a number of cupolas in this district which are operating under more or less obsolete or wasteful conditions, which in many cases could be improved at a comparatively small cost which would amply pay for itself.

There is, of course, a danger in putting new wine into old bottles and losing it, but though it is sometimes impossible to modernise old plant and an entirely new cupola is necessary, nevertheless there are many instances where much of the old plant and methods may be improved out of recognition.

It is possible to increase the output of cupolas melting ordinary grey phosphoric iron to 25 to 40 per cent. beyond the ordinary rated capacity, as the following table shows:—

Cupola internal dia. at tuyeres.	Ordinary rated capacity.	Possible output.
36 ins.	4 tons/hr.	6 tons/hr.
42 ,,	6½ ,,	9 ,,
48 ,,	8½ ,,	12 ,,
54 ,,	10½ ,,	15 ,,
60 ,,	12½ ,,	18 ,,

A Concrete Example.

A cupola 3 ft. internal dia. was yielding 3½ tons per hr. and was being run for about 5 hrs. at a time before the lining needed patching. A guarantee to get 6 tons per hr. was given, provided that a new blast belt and tuyeres of approved design was installed, together with a fan of sufficient capacity, and charges were weighed and blast volumes measured. After the necessary alterations were made the cupola yielded over 5 tons an hr. of hot metal using the old fan, and without actually weighing the charges and measuring the blast; and the foundry management was satisfied that it was capable of yielding well over the guaranteed output of 6 tons per hr. when the new fan was installed. Moreover, it was found possible to run the cupola continuously for nearly 24 hrs. before emptying it and patching the lining. The result was that where they were running 6 hrs. in a day and melting 21 tons of iron, they proved that when pressed they could melt 100 tons of iron within 24 hrs.

From current gossip many foundries are using 10 to 12 per cent. charge coke (say 2 to 2½ cwts.) to the ton even on melting ordinary grey phosphoric foundry iron. Generally speaking this is too much. It is usually possible to reduce the coke to 7 per cent. (say 1½ cwts.) and even to 6 per cent. or less to the ton after making certain alterations, and it is worth noting, for example, that a foundry melting 150 tons of metal a week and reducing its coke consumption from 10 to 7 per cent. of the weight of iron is saving 30 per cent. of the total coke used, which at 25s. a ton for foundry coke means a saving of £280 on a 50-week year.

Low Ash Coke.

Another way in which a substantial saving can be effected is by mechanical charging. Some systems of mechanical charging are by no means satisfactory, but others are simple and economical. There is at least one brand of coke with as little as 3 to 4 per cent. ash, and experience is showing that the wise use of such a coke gives quick melting, improved yields, and low coke consumption, which fully compensates for the extra cost. It is also of special interest where low sulphur content in iron is important.

In a short discussion which followed a member expressed the opinion that the coke used to-day was not as good as it was 20 years ago, while another member said they did not keep a check on coke consumption, and he agreed that in this respect they were behind the times.

MR. THORPE said that only recently in a tap of 34 tons 18 cwts., the coke consumption was 2 tons 18 cwts.

The Manufacture of Sand-Spun Pipes.

(*Concluded from page* 304.)

is also increased, and for these reasons it has been possible to reduce the thickness of the Sand-spun pipe is compared with the pit-cast variety. Hence, the weight of a 16-ft. Sand-spun type, which is the only length made, is approximately that of the standard pit-cast 12 ft. length. Hence, ease in transport and fewer joints.

Sand is the natural bed for molten metal. A sand mould is used in both the pit-cast pipe and the Sand-spun pipe. The sand mould determines the rate of cooling of both types of pipe. Hence, the physical characteristics of the metal in both cases are similar. All engineers who are concerned with pipes have been familiar with the characteristics of the pit-cast one for the whole of their professional lives. Hence, the purchaser of the Sand-spun pipe does not purchase an experimental article, but purchases one containing all the characteristics with which he is familiar, in addition to the virtual certainty that his pipe is an all-metal one, and not possibly partly voids, or non-metallic material.

MESSRS. DORMAN, LONG & COMPANY, LIMITED, of Middlesbrough, have secured an order for 1,000 tons of steel tramway rails from the Montreal Tramways Company. The order was obtained because the depreciation in the £ has made the British price more attractive than the American. The same factor opens up the possibility of orders being received from other Canadian cities.

The Heterogeneity of a Sand-Cast Steel Ingot.*

By A. Kříž, Ing. Dr. (Pilsen, Czecho-Slovakia).

(*Abridged.*)

To study the heterogeneity of large alloy-steel ingots made in the steel plant of the Skoda Works, Pilsen, some ingots—which were cast and became solid under various conditions—were investigated. These conditions deviated in some cases from the usual practice. An extreme case was an ingot cast in a preheated sand mould, so that the rate of solidification was considerably slower than that in a chill-cast ingot.

The shape and dimensions of the mould are shown in Fig. 1. The mould consisted of two parts; the lower part served for the ingot body and the upper part for the ingot head. About three-quarters of the mould for the ingot body was dug out in the foundry floor and one-quarter was moulded in an iron frame. A tangential

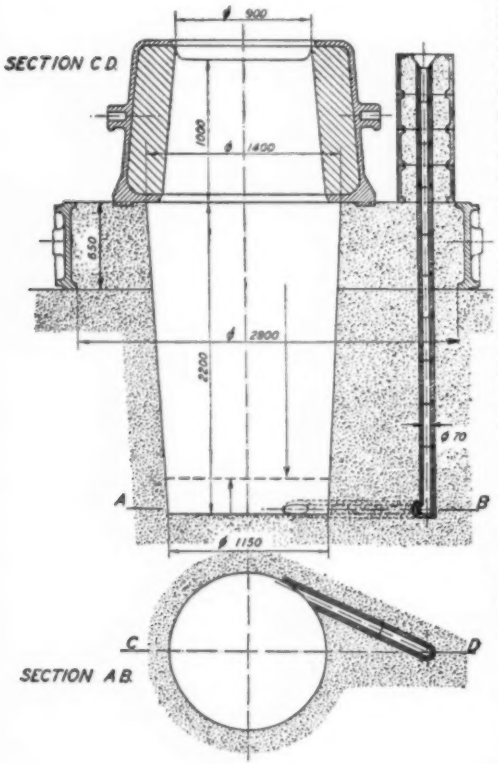


Fig. 1.—The Mould for the Ingot Investigated.

runner was arranged to communicate with the mould base. The material for the mould was prepared from ground burned fireclay and burned shale. A raw refractory clay was used as a binder. The main components of the mould wash were ground silica, ground burned refractory clay, raw refractory clay and graphite. The head was formed by a firebrick lining enclosed in an iron shell.

The mould was dried by hot gases—having a temperature of 680 to 700 deg. C.—from transportable coke furnaces provided with blowers. The mould top was heated separately to 450 deg. C. From the moment the heating of the mould was stopped until the commencement of casting about 3 hrs. elapsed. By this time the temperature of the lower part of the mould was about 400 deg. C. This temperature was not actually measured, but was estimated by analogy with other similar cases.

Production Data.—The steel was made in an acid open-hearth furnace. The charge was made up of: Swedish pig, 6,000 kgs.; English pig, 1,800; steel scrap (chromium-nickel steel), 22,230; ore, 100; nickel, 280; ferro-manganese, 300; ferro-silico-manganese, 200; ferro-chromium, 65; ferro-silicon, 20; ferro-molybdenum, 102 kgs. The time from the melting-down of the charge to its tapping was 8 hrs.

The teeming of the ingot body lasted 19 min. 45 sec., and it weighed 28 tons. After the completion of teeming, the top of the ingot was covered with a layer of wood charcoal and moulding sand. The ingot was left to cool in the mould for 123 hrs. 20 min. When lifted from the mould the ingot had a surface temperature of approximately 700 deg. C. It was immediately transported to the heating furnace and slowly heated to 800 to 820 deg. C., and was kept at this temperature for about 8 hrs. Then the heating was stopped and the ingot allowed to cool slowly in the furnace for 227 hrs. At the end of this interval its temperature had dropped to approximately 100 deg. C. The ingot was then brought to the casting pit. Thus the total time of cooling from the end of teeming to the removal from the heating furnace was 385 hrs.

The external shape and the dimensions of the ingot are to be seen in the sketch of the mould (Fig. 1). The ingot was cut exactly along its longitudinal axis. The features of the pipe were clearly demonstrated by this axial section. The pipe was symmetrical with the longitudinal axis and had the shape of an inverted truncated cone followed by a cylinder. The height of the inverted cone amounted to approximately three-quarters of the head. The cylindrical part of the pipe, which was a continuation of the smaller base of the inverted cone, had at its upper and lower ends a diameter of 180 mm. (7 in.) and in the middle approximately 205 mm. (8 in.); thus, the diameter of this hollow cylinder amounted to 13 per cent. of the diameter of the ingot body. The total depth of the pipe, measured from the top of the ingot to the bottom of the pipe, was 60 per cent. of the total height of the ingot. On the surface of the axial section, cavities—from 0.5 to 2 mm. (0.02 to 0.08 in.) wide—were clearly visible.

A considerable portion of the Paper is devoted to a study of the macrostructure of an axial section of the ingot.

The vertical segregations corresponding to the A-segregations in ingots cast in the usual manner were much broader and more pronounced than in chill-cast ingots; they were nearer the lateral face of the ingot, and disappeared at a greater distance from the ingot axis than those in chill-cast ingots. The number, thickness and intensity of these stripes increased towards the top of the head. An endeavour was made to find out by analysis what was the difference in the content of sulphur and phosphorus in the segregation and in places adjoining it. Drillings for analysis were obtained by means of drills the diameter of which was equal to the width of the segregations. The boring was carried out to a depth equal to one-half of the diameter of the drill. A second analysis was made on drillings taken in the immediate neighbourhood of the segregations at their outer side. The samples were taken in the upper part of the ingot body and in the head.

The content of phosphorus was:—

		Per cent.			Per cent.
In segregation	*A*	0.056;	in its neighbourhood		0.020
„ „	*B*	0.161;	„	„	0.022
„ „	*C*	0.100;	„	„	0.035
„ „	*D*	0.092;	„	„	0.027
„ „	*E*	0.063;	„	„	0.031

The content of sulphur was:—

		Per cent.			Per cent.
In segregation	*A*	0.034;	in its neighbourhood		0.012
„ „	*B*	0.046;	„	„	0.015
„ „	*C*	0.083;	„	„	0.014
„ „	*D*	0.065;	„	„	0.016
„ „	*E*	0.040;	„	„	0.018

Thus, the content of phosphorus in the segregation was from 2 to 3½ times greater, and the content of sulphur from 2 to 6 times greater, than those in their neighbourhood. In the part of the ingot below the bottom of the pipe, the segregation formed arc-shaped stripes convex to the ingot base. It is obvious that these segregations arose in a different manner from those of the main vertical segregations.

Chemical Composition.—One half of the axial section served for samples for chemical analysis. The positions from which the samples were taken formed a regular network consisting of three vertical rows. The first row was 65 mm. (2.56 in.) from the lateral face, the third was drilled on the ingot axis, and the second was chosen half-way between the lateral face and the axis. The distance between the rows was 257 mm. (10.12 in.). They were bored with a 25-mm. (1-in.) drill to a depth of 20 mm. (0.8 in.). Owing to carburisation the metal immediately below the pipe was extremely hard, so there was no possibility of taking a sample from that place. It therefore seems, in all probability, that the zone of highest segregation eluded determination. Altogether twenty-six samples were analysed. The results are reproduced in Fig. 2, and are summed up in Table I.

The analysis of a small 7-kg. test-ingot was taken as a basis for the estimation of the degree of segregation. It would perhaps have been better to take as a basis an arithmetical average of the analyses of a large ingot; in that case, however, the number of analyses required would have been much greater than was actually taken. The position of the minimum values of carbon, phosphorus and sulphur appears at the axis of the ingot, namely, above the first third of the distance between the ingot base and the pipe bottom. Maxima of elements which show strong segregation were found in the part around the pipe bottom; high values were also observed at the top of the head.

Table I.—*Chemical Composition of Ingot compared with Test Ingot.*

Element.	Analysis of the small test ingot.	Lowest value.	Highest value.
	Per cent.	Per cent.	Per cent.
Carbon	0.35	0.27	0.48
Manganese	0.59	0.56	0.63
Silicon	0.27	0.24	0.29
Phosphorus.. ..	0.033	0.018	0.051
Sulphur	0.021	0.012	0.034
Nickel	2.06	2.03	2.08
Chromium	0.35	0.35	0.36
Molybdenum ..	0.24	0.22	0.30

Comparison of the Heterogeneity of the Sand-Cast Ingot with that of Chill-Cast Ingots.

The properties of this sand-cast ingot were compared with those of chill-cast ingots which had approximately the same chemical composition.

The composition of the chill-cast ingots investigated varied within the following limits: Carbon, 0.30 to 0.31 per cent.; manganese, 0.55 to 0.61; silicon, 0.32 to 0.33; phosphorus, 0.019 to 0.030; sulphur, 0.007 to 0.012; chromium, 0.46 to 0.50; nickel, 2.09 to 2.16; molybdenum, 0.24 to 0.27 per cent.

The ingots cast in the usual manner in ingot moulds differed between themselves only in the temperature of teeming. Certain differences in the size of the primary crystals which developed in these ingots are—in the author's opinion—correlated with this circumstance. Therefore, when describing these ingots it is stated—where necessary—whether the particular ingot was cast at a higher or lower temperature. The differ-

* Extract of Paper presented to the Spring Meeting of the Iron and Steel Institute.

ence in temperature of teeming amounted to approximately 40 deg. C.

The analysis of the ingot made by the Harmet process* was: Carbon, 0.31 per cent.; manganese, 0.55; silicon, 0.18; phosphorus, 0.028; sulphur, 0.022; nickel, 2.09; chromium, 0.41; molybdenum, 0.26 per cent.

Thus, the ingots investigated differed essentially in the rate of cooling during solidification. The rate of cooling of the sand-cast ingot was the slowest, whereas the ingot made by the Harmet process cooled most rapidly because the ingot mould was provided with hoops and was intensively water-cooled.

For the sake of brevity, in the following, the sand-cast ingot will be denoted as I, the chill-cast ingots as II, and the ingot made by the Harmet process as III.

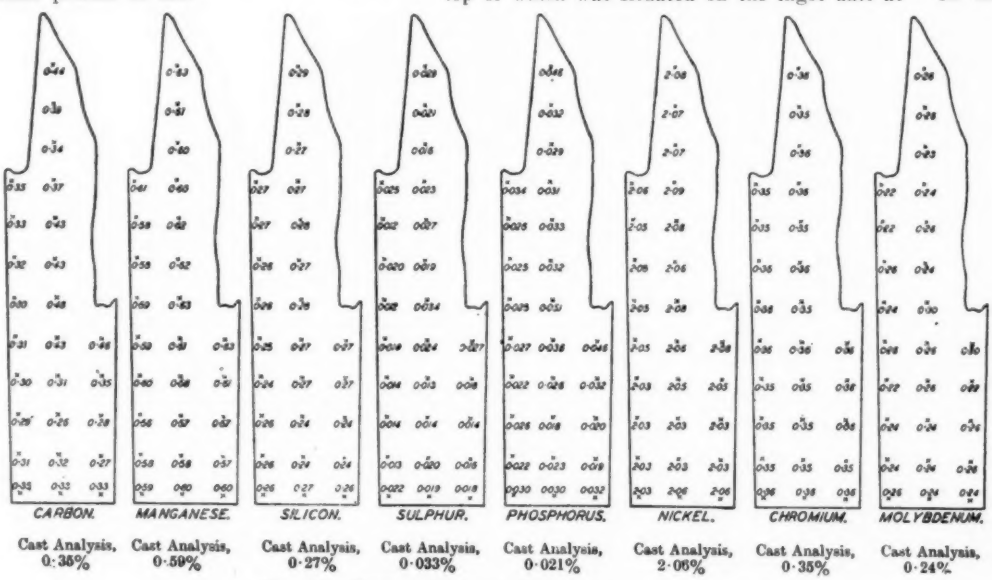


FIG. 2.—DISTRIBUTION OF ELEMENTS.

The dimensions and weight of the ingots are given in Table II.

The Primary Crystallisation.—The surfaces of the separate primary crystals could be very well differentiated on an axial section by means of Kocárek's etching method in the case of ingots II and III. In the case of ingot I this etching did produce marked effects. The primary grains in all types of ingots were surrounded by a ferritic network. The secondary structure in ingot I was an essentially pearlitic one, whereas in ingots II and III it was of a sorbo-pearlitic nature. The primary grains in the body of ingot I contained only small islands of sorbo-pearlite. Small particles of troostite had separated near the ferritic network of primary crystals in ingots II and III.

TABLE II.—*Dimensions and Weights of Ingots.*

Type of ingot.	I.	II.	III.
Cross-section ..	Circular	Octagonal with rounded edges.	Octagonal with rounded edges.
	In.	In.	In.
Dia. at base ..	45.28	43.31	53.15
Dia. of ingot body below head ..	55.12	51.18	43.31
Height of ingot body	86.62	86.62	—
Total height of ingot (including head) ..	127.17	132.88	135.83
	Kgs.	Kgs.	Kgs.
Weight	28,100	25,400	33,400

TABLE III.—*Depth of the Columnar Zone.*

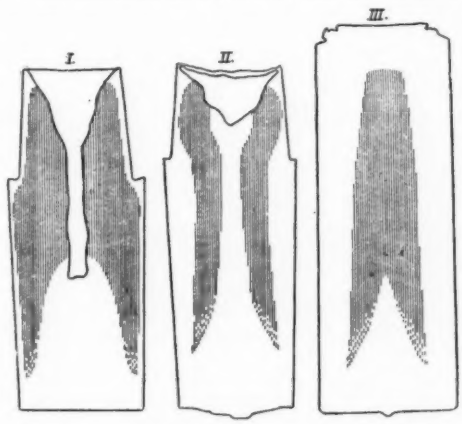
Type of ingot.	I.	II.	III.
	In.	In.	In.
In lower part of ingot body ..	2	6.10	7.08
In upper part of ingot body ..	1	3.54	14.16

* "Iron and Coal Trades Review," September 19, 1930.

Table III shows the depth from the ingot faces reached by the zone of columnar crystals in the ingots investigated.

The nature, size and distribution of the crystals in the granular zones in ingot I were entirely different from those in ingots II and III.

A sketch showing the boundaries of the separate zones in ingots of type II is given in Fig. 3. Only the main features of the phenomena observed are described. The following typical formations were observed. In the middle part of the ingot was a cone-shaped region, the top of which was situated on the ingot axis at approximately half the height of the ingot body. This region always contained very small primary crystals, the sectional area of which varied from 8 to 20 sq. mm. (0.012 to 0.031 sq. in.). The normal dendrites in crystals of this region could be well revealed by means of Rosenhain's etching reagent.

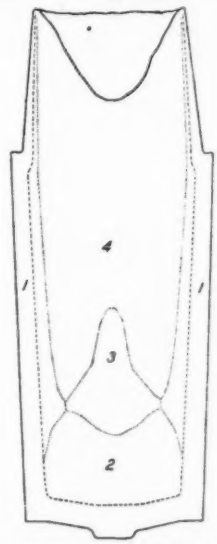


I.—Ingot cast in a preheated sand mould. II.—Ingot cast in an ingot mould. III.—Ingot made by the Harmet process.

FIG. 4.—REGIONS OF VERTICAL Λ-SEGREGATIONS IN DIFFERENT INGOTS.

This cone-shaped region rested on a sort of pedestal having, as it were, the shape of a truncated cone; the upper surface of this cone was concave, resembling a crater. The size of the primary crystals in this "pedestal" varied greatly. In one case the average sectional area of the grains was found to be about 160 sq. mm. (0.248 sq. in.); in another case it was estimated at 9 sq. mm. (0.014 sq. in.). The teeming temperature in the first case had been purposely higher, whereas in the second case it was kept lower. It is very significant that in this region the normal dendrites could not be revealed by means of Rosenhain's etching reagent. The formations discussed by this etching reagent could in some cases be identified as degenerated dendrites, and sometimes they had the appearance of grains. This structure was surprising in so far that it occurred even in very large crystals. It is probable that the crystals of this region had grown in a different manner from those of the other zones. Between the zone of columnar crystals at the base and the "pedestal" region there was a layer of intermediate crystals.

In the remainder of the granular zone the crystals of small size were situated along the sides of the region. The size of the crystals increased in the direction of the ingot axis and towards the pipe. On etching with Rosenhain's reagent all crystals showed a normal dendritic structure.



1.—Columnar zone. 2.—"Pedestal" (Truncated Cone). 3.—Conical region of small crystals.

FIG. 3.—DIAGRAMMATIC REPRESENTATION OF THE BOUNDARIES OF THE VARIOUS ZONES OF CRYSTALLISATION IN A TYPE II INGOT.

Zones of granular crystals in ingot III are similar to those in ingots of type II. The cone in the middle—composed of small crystals—resting on a "pedestal" was surrounded by a region of large grains. The surface of the axial section of the Harmet pressed ingot was not etched with Rosenhain's reagent, so that it cannot be said at present which was the dendritic structure in separate regions.

TABLE IV.—*Positions of Vertical Segregation Regions.*

Type of ingot.	I.	II.	III.
	In.	In.	In.
Distance from ingot faces at bottom ..	2.36	6.30	11.02
Distance from ingot faces at top of ingot body ..	1.18	11.02	13.78
Distance from ingot axis	15.75	3.54	Zero.

Sulphur Segregations.—The region of vertical segregations (Λ-segregations) depends to a certain extent on the rate of cooling. The lower the rate of cooling the nearer to the ingot faces will the region of these segregations begin, and the farther away from the ingot axis will it disappear.

(*Concluded on page* 316.)

Institute of British Foundrymen.

WEST YORKSHIRE BRANCH.

A PRESENTATION TO MR. WISE.

The annual general meeting of the West Riding of Yorkshire Branch of the Institute of British Foundrymen took place on April 30, at the Bradford Technical College. Mr. A. S. Worcester (Huddersfield) presided.

The Hon. Secretary (Mr. S. W. Wise), in his annual report, observed that despite the cloud of depression which still overshadowed the industrial world, he felt the members would agree that, after a careful review of the work of the Branch during the past session, they had every reason to retain the optimistic note sounded at the close of the previous year. The financial position of the Branch was stronger than in the previous year; they had the second lowest expenditure per head of all the branches of the Institute, and their arrears of subscriptions were the lowest in the country. Whilst nobody was proud of having any arrears at all, it was certainly a matter of some little pride that West Yorkshire was freer from this difficulty than any other. That the policy of the Council and the Branch had not proved a false economy was shown by the slow but sure increase in membership and the potential revenue of the Branch. By "potential revenue" he meant the revenue on the assumption that all members paid up, and this figure had increased during the past year from £119 to £134.

All the monthly meetings planned on the syllabus had duly taken place and the type of lecture submitted to the Branch had been of a high standard. One of the lectures had been submitted to the Literary Committee of the Institute for consideration with a view to a diploma award. Highly interesting visits had been paid during the session to the works of Messrs. Dean, Smith & Grace, Limited, of Keighley, and Messrs. Thos. Broadbent & Sons, Limited, of Huddersfield. That the enthusiasm of the members remained unabated was shown by the fact that the attendance at meetings had averaged 40 per cent. of the total membership—an average considerably higher than that of most technical organisations.

The Craft Certificate Scheme for foundry and pattern-shop apprentices had been launched and had met with a good response in some West Riding centres, though it was to be regretted that some other districts had not as yet shown the same readiness to take advantage of the facilities offered. The educational authorities associated with the Institute in this scheme were more than willing to co-operate in every possible way, but it seemed though there was still quite a lot of spadework to be done among the youth of the industry in some areas to make them appreciate the real nature of the benefits available. It was, suggested Mr. Wise, the duty of every member of the Branch to do all in his power to establish contact between technical education authorities and prospective students. That progress had been made in the West Riding was due in very large measure to the untiring efforts of the Branch President, Mr. Worcester.

Another respect in which the past session had been notable was the inauguration of an annual dinner. This had been embarked upon after very careful consideration and inquiry as to its prospects of success. The result of the efforts of the sub-committee responsible was such that he believed the Branch could look forward to the event as having become firmly established as an annual one. The technical library of the Branch retains its interest to members. The fact that the Brighouse Association of Engineers, during the session, invited the Branch to provide a lecturer to speak on matters of mutual interest—as had been done in the case of the Keighley Association of Engineers in the previous session—was further proof of the spirit of co-operation which existed locally.

Mr. Wise, presenting the financial statement for the past year, showed a gross income amounting to £175 13s. 4d., and a credit balance at the end of the year of £39 11s., as compared with £33 10s. 7d. last year.

The following officers were elected for the next session:—

President: Mr. A. S. Worcester (Huddersfield)—who, despite the general custom to change President each year, was re-elected especially because of his close personal association with the Craft Certificate scheme and area technical classes, which were still not completely developed.

Vice-Presidents: Mr. R. D. Welford (Bradford) and Mr. J. J. Watson (Huddersfield).

Hon. Treasurer and Secretary: Mr. S. W. Wise.

Additions to Council: Messrs. H. Forrest (Bradford), H. Roberts (Leeds) and F. K. Neath (Keighley), late Hon. Secretary of the Birmingham Branch.

Auditors: Messrs. R. D. Welford and W. Hird.

Librarians and Registrars: Messrs. Stanley F. Wise and G. Booth.

Representative to General Council: Mr. F. K. Neath (Keighley).

Representatives to Technical Committee of the Institute: Mr. Worcester and Dr. H. W. Swift, M.A., B.Sc., M.I.Mech.E. (Bradford Technical College).

Presentation to the Secretary.

The business proceedings having concluded, an interesting event of the evening was the presentation of a handsome clock to Mr. S. W. Wise, in appreciation of his valued services as Secretary of the Branch for the past seven years—a period in which the Branch had been built to a state of distinct success.

The President, in making the presentation, said the idea had arisen in the minds of one or two past-presidents, and he was delighted with the manner in which the members generally had responded to show their appreciation of the efforts of Mr. Wise on their behalf. Nobody was in a better position, of course, to know the extent of a secretary's work than past-presidents, and probably even their idea was small by comparison with the actual volume of time and effort called for from a secretary. Mr. Wise was the ideal secretary, and they all hoped they would have him long with them in that capacity. (Hear, hear.) He was a friend to every member, whether he be an owner or an operative. The West Riding Branch was better esteemed by the local industry, as well as by the Institute, than at any time in its history, and he fully believed this was chiefly due to the skilful guidance and enthusiasm of Mr. Wise in the secretaryship. (Applause.)

Mr. W. G. Thornton (past-president, 1925-30) said perhaps he was in a better position than any other man in the Branch to-day to know what a continuous stream of work was involved in the secretaryship, because during his own presidency it fell to his lot to take charge of some portion of the secretarial work himself during a period of somewhat lengthy illness of Mr. Wise. He confessed that the experience was particularly enlightening.

Mr. H. Summersgill, Mr. W. Parker and Mr. H. Sayers, all past-presidents, endorsed the eulogies of previous speakers.

Mr. R. D. Welford (senior Vice-President) added tribute on behalf of the rank-and-file members and also, he believed, as the oldest member of the Branch to-day and one of the four oldest members of the Institute.

Mr. J. R. Nunns (Low Moor) said he would like to say, as a Yorkshireman, but a newcomer to the West Riding Branch from the London Branch, how delightful it was to be present at an occasion of that kind on his first attendance at a West Yorkshire meeting. He was, as yet, a stranger to the members, although a native of the county, but the tone of the gathering indicated that one need not be a stranger long in that Branch. As a Yorkshireman he had, whilst in London, followed the activities of the West Riding Branch with keen interest, as reported in the columns of The Foundry Trade Journal, and he had always felt proud of the obvious activity and virility of that Branch. It was a pleasure now to come among them and to realise how warmly they were voicing their appreciation of one who had rendered them service.

Mr. Wise, responding to the many expressions of appreciation, said he quite admitted the secretaryship involved a considerable volume of work, but when it was a work of pleasure the burden of it did not feel so heavy. One of the greatest privileges of a secretary was that he came into contact with every member, and that advantage brought him a host of good friends whom probably he would never otherwise have made. His experience in the office had been happily rich in that regard. At the same time, he could not agree with the speakers in the way they said so much of the success of the Branch was due to his own work. He had been particularly fortunate in his fellow-officers, and especially in a series of helpful Presidents who were never lacking in rendering all the support that lay in their power. He felt he owed a great deal to the example of good work set him by the late Mr. Love in secretarial methods, a man who had himself rendered invaluable service and who had had to retire at a very difficult time. The Branch had begun in a burst of enthusiasm but after a while became rather stale. Mr. Liardet as President, and Mr. Love as Secretary, carried out their duties in able manner. He then reviewed the activities of the various Presidents, speaking finally of Mr. Worcester's presidency, remarking that Mr. Worcester's great ability in service for the industry, especially his enthusiastic work on behalf of the Craft Certificate scheme and the classes, was fresh in the minds of them all, and they had shown it that day by re-electing him to carry on with the work in the chair. Mr. Wise felt he owed a very real tribute to all these fellow-workers in the movement. Mr. Wise, in thanking the members for their gift and for the kindness which it represented, said he wished particularly to express his warm thanks for the mention which had been made by various speakers to Mrs. Wise, to the part she had played in helping him, and to the lonely times which, inevitably, she had had to endure when he was engaged on secretarial duties.

B.C.I.R.A. Elects New Members.

At a Council meeting of the British Cast Iron Research Association held at the Institution of Mechanical Engineers on May 4, the following firms were elected members of the Association:—Messrs. John Thompson (Wolverhampton), Limited, Ettingshall Works, Wolverhampton, and Henry Balfour & Company, Limited, Durie Foundry, Leven, Fifeshire. Mr. F. K. Neath, B.Sc., lately on the staff of the Association and now connected with Keighley Laboratories, Limited, was elected an associate member.

Institute of British Foundrymen.

LONDON BRANCH.

Annual General Meeting.

The Annual General Meeting of the London Branch of the Institute was held in the rooms of the Junior Institution of Engineers, 39, Victoria Street, Westminster, S.W.1, on May 12, 1932. Mr. H. G. Sommerfield (Acting President) presided. The minutes of the preceding annual general meeting were taken as read, and were confirmed and signed.

Annual Report.

The BRANCH-HON. SECRETARY (Mr. H. W. Lockwood) presented his report for the year 1931-32, as follows:—

The work of the Branch has been carried on successfully during the present year, and the average attendance at meetings has been well maintained. The untimely death of our President, Mr. H. C. Dews, came as a severe shock to the London Branch and to the whole industry, but his memory will always remain a live force in our gatherings. The news of the death of Mr. J. Oswald, a Founder and Past-President of the London Branch, was received by all members with deepest regret.

During the year 12 new members and associate members were enrolled in the Institute from the London Branch, and, after allowing for resignations and transfers, the membership of the Branch stands to-day at 260 as compared with 263 a year ago.

At the monthly meetings, which were held in the lecture room of the Junior Institution of Engineers, a wide range of subjects was presented and discussed. It is gratifying to note that members are taking a more active part in the discussions, to the benefit of all concerned.

An interesting occasion was the visit of Dr. Guido Vanzetti, who travelled from Italy to lecture to the Branch in March. An informal dinner in his honour was given before the lecture.

Members of the London Branch were the guests of the Institute of Metals at the Joint Meeting held at the rooms of the Society of Motor Manufacturers and Traders in December, and a very enjoyable evening was spent. The Annual Dinner of the Branch also took place in December. About 80 members and their guests attended, and Sir Gervais Rentoul, K.C., President of the British Iron Founders' Association was the guest of honour. The financial position of the Branch is strong, and the balance in hand at the end of the year was £80 2s. 1d., as compared with £37 4s. 3d. at the end of the preceding year. The Junior Section has been very poorly supported, despite the excellent Papers which have been presented, and at the Annual Meeting it was decided to close it down.

The CHAIRMAN, in reply to a question concerning the closing down of the Junior Section, said that that matter would be discussed by the Branch Council, whose recommendations would be submitted to a general meeting. On the motion of MR. G. C. PIERCE (Past Branch-President), seconded by MR. J. A. SMEETON, the Secretary's Report was adopted.

Election of Officers.

MR. V. C. FAULKNER (Past-President of the Institute and of the Branch) presided temporarily at this stage, and proposed the election of Mr. H. G. Sommerfield (who had been Acting-President since the death of Mr. H. C. Dews) as President for the ensuing year. He recalled that seven or eight years ago he had had the pleasure of proposing the election of Mr. Sommerfield as hon. secretary, and said that that was one of the best things he had ever done for the Branch. In proposing Mr. Sommerfield's election to the Presidency, he felt sure he was voicing the wishes of everyone present.

MR. A. F. GIBBS (Past Branch-President), seconding, said he had hoped to have the pleasure of proposing Mr. Sommerfield's election, but had given way to Mr. Faulkner in view of the latter's long association with Mr. Sommerfield. It was a great pleasure, however, to be able to second. There were no further nominations, and Mr. Sommerfield was unanimously elected.

MR. FAULKNER expressed congratulations, and assured Mr. Sommerfield that he would have the support of all members of the Branch to make his year of office successful.

MR. SOMMERFIELD again occupied the chair at this stage, and expressed his gratitude for the confidence of the members. He had enjoyed, appreciated and esteemed his connection with the Institute, as hon. secretary of the Branch for nine years and also as a Vice-President more recently. Although he did a fair amount of public work and had various activities in and out of London, it needed a great deal to distract his attention from matters appertaining to the Institute, and if he could give to it the same measure of work and activity, energy and zeal, thought and inspiration, during the coming year as he had tried to give it in the past, he would be satisfied; he hoped also that the members would not regret, by the end of the year, having entrusted him with their confidence.

Vice-Presidents and Other Officers.

It was reported that Mr. A. W. G. Bagshawe (Junior Vice-President during the past year) did not offer himself for re-election.

The following were elected:—

Senior Vice-President.—Mr. C. H. Kain.

Junior Vice-President.—Mr. A. S. Beech.

Hon. Secretary.—Mr. H. W. Lockwood.

Hon. Treasurer.—Mr. A. F. Gibbs (Past Branch-President).

Members of Council.

Messrs. H. S. Clarke, A. J. Cree and A. S. Beech retired from the Council by rotation (the latter retaining a seat on the Council by virtue of his election as Junior Vice-President). The following were elected to fill the three vacancies: Mr. F. J. Cree, Mr. J. Deschamps and Mr. H. C. Marshall.

Other Appointments.

Mr. Wesley Lambert and Mr. J. W. Gardom were elected to the Technical Committee of the Institute.

Messrs. J. W. Gardom, A. J. Cree, V. Delport, F. J. Wares and A. W. G. Bagshawe were elected Delegates to the General Council.

This concluded the business of the Annual General Meeting.

Book Review.

Säurebeständige Bronzen (Acid - Resisting Bronzes), by WILLI CLAUS and HANS FINCKE. Published by the Verlag Von Wilhelm Knapp, Halle (Saale), Germany. Price, paper backs, 12 marks 50 pfennigs, and bound, 13 marks 80 pfennigs.

About half this book is devoted to copper-tin alloys and their behaviour, in the as-cast and heat-treated conditions, when subjected to the corrosive action of materials such as ammonia, hydrochloric, sulphuric and phosphoric acids, caustic potash and salt sprays. These tests have been carried out under both short-time and prolonged conditions.

The second section includes red brass, lead-tin bronze, antimony-tin bronze and Monel metal. A great feature of this book is the excellent bibliography, in which no less than 724 references are given. As a text-book its value can be gauged somewhat by the fact that in addition to 37 illustrations, mostly micrographs, there are 76 graphs and 42 tables, contained within its 140 pages. For those of our readers who can read German and are interested in non-ferrous alloys, we very strongly recommend the purchase of this book.

To Present American Exchange Paper.

Mr. Ralph S. MacPherran, who ranks very highly amongst metallurgists working in the field of grey cast iron, has for many years been prominently identified with the work of the committees of the American Foundrymen's Association and the American Society for Testing Materials. Mr. MacPherran has been noted for his co-operation with technical organisations and the assistance he has given to many young metallurgists. His publications include:—

"Comparative Tests of Steels at High Temperatures," A.S.T.M., June, 1921.

"Tests of Chrome-Nickel Steel at High Temperatures," A.S.T.M., June, 1927.

"Annealing Grey Cast Iron" (Harper and MacPherran), A.F.A., June, 1922.

"Spheroidised Cementite in Hypoeutectoid Steel" (Harper and MacPherran), A.S.S.T., September, 1924.

"High-Test Cast Iron," A.F.A., April, 1929.

"Effect of Section and Various Compositions on Physical Properties of Cast Iron," A.S.T.M., June, 1929.

MR. RALPH S. MACPHERRAN.

"Effects on Cast Iron of Prolonged Heating at 800 to 1,000 deg. Fah." (R. S. MacPherran and R. H. Krueger), presented at 1930 A.F.A. convention.

Mr. MacPherran's technical association affiliations are: American Foundrymen's Association, American Society for Steel Treating, International Association for Testing of Materials, American Society for Testing Materials and the American Chemical Society.

Ralph S. MacPherran was born on February 1, 1871. He received his technical training at the University of Wisconsin and the University of Michigan, graduating in 1892 with a B.Sc. degree in chemistry. On leaving college he was with the Illinois Steel Company for three years, at the Joliet and South Chicago works, and became connected with the E. P. Allis Company, Milwaukee, in 1895. Leaving that firm in 1907, Mr. MacPherran spent one year with the J. I. Case Threshing Machine Company of Racine, Wis., but returned to the newly-formed Allis-Chalmers Manufacturing Company, Milwaukee, in 1908. He has been connected with the Allis-Chalmers organisation ever since in charge of their chemical and physical laboratories, holding the present position of chief chemist.

This Week's News in Brief.

Trade Talk.

The Leeds Forge Company, Limited, is being wound up voluntarily. Mr. E. D. Taylor, 7, Bond Place, Leeds, is the liquidator.

The new Lambeth Bridge over the Thames has now almost been completed by Messrs. Dorman, Long & Company, Limited, of Middlesbrough. The bridge is to be officially opened to traffic in July.

The Free State Minister of Finance, introducing his Budget in the Dail on Wednesday, announced that a tax would be imposed on constructional steel, imported fabricated and ready for erection.

A fire broke out in the Clydebank shipyard of Messrs. John Brown & Company, Limited, on Monday night. It originated in the riggers' loft and spread to the copper store. The fire brigade succeeded in confining the fire to the two departments.

Messrs. Scotts' Shipbuilding & Engineering Company, Limited, Greenock, have secured a contract to build a new ship for the China Navigation Company, Limited, London. Details of the vessel are not yet available, but the contract will provide employment for a considerable number of men. The China Navigation Company have a long association with Greenock, and many of their steamers have been built by Messrs. Scott & Company.

Messrs. Albion Motors, Limited, Scotstoun, Glasgow; R. Y. Pickering & Company, Limited, Wishaw; and Messrs. John Stewart & Company, Limited, Wishaw; are sharing in a contract for 120 new single-decker 'buses for the Glasgow Omnibus Company for service on the Glasgow-Lanarkshire and Glasgow-Dumbartonshire areas. All the 'buses will be fitted with governor-controlled engines for regulation of the maximum speed.

The members of the Electrical Association for Women, Edinburgh, visited the work of the Falkirk Iron Company, Limited, Falkirk, on May 11, with a view of examining the latest in electrical cookers, fires and other appliances manufactured by the Falkirk company. The party was met by Capt. Kennard, the managing director, and members of the management and technical staff, who conducted the members through a few of the departments, including the patternmaking, core-making and moulding shops. The ladies were much impressed, and to some extent awed, at the sight of the molten metal running out of the cupolas and being conveyed in ladles. In the electrical department they witnessed a demonstration and received an explanation of the various types of cookers, fires, etc. The ladies appeared to be well versed in the technical details and finer points of construction of the apparatus, and asked many questions.

After the Whitsun holiday the new mill at the Courtybella Works, Newport, of the Whitehaven Iron & Steel Company, Limited, which was put into commission a year ago, will operate a temporary double shift. At present the works have an order for 5,000 tons of tube strip for Russia. The company installed in 1922 modern equipment for the production of tube strip, but for some years past this has only operated a few shifts in each year. Now there are prospects of a good demand in this line, both in the home and export markets, and it is possible, if trade continues to expand, that the double shift will be permanently established, and so absorb a number of men who became unemployed on the closing of the company's works at Tredegar. Further employment will be found later on, as it has been decided to convert the auxiliary bar mill into a completely separate unit, and embody in it a specially-designed double-strand continuous wire-rod mill. A start has been made on the foundations.

New Companies.

Air-Cooled Fire Bars, Limited.—Capital, £500. Solicitors: Robbins, Olivey & Lake, 218, Strand, W.C.

Ductile Steels, Limited.—Capital, £7,600. Directors: F. A. Hall, Hall Street, Willenhall; E. Parry and C. H. Batten.

Personal.

Mr. W. E. S. Patrickson was elected President of the Sheffield Crucible Steel Makers' Association for the third year, at the annual meeting held on May 10.

Mr. W. Benton Jones, chairman of Steel Industries of Great Britain, Limited, and the United Steel Companies, Limited, has been elected a director of the Westminster Bank, Limited.

Mr. W. W. Storr, of Darlington, who was for many years secretary and subsequently a director of Messrs. Bolckow, Vaughan & Company, is leaving the North Country to take up residence in Sussex.

On his retirement as foreman of the wagon department of Messrs. Hurst, Nelson & Company, Limited, Motherwell, Mr. Robert Murdoch was made the recipient of a presentation from his fellow-workmen. Mr John Miller, joinery department foreman, presided, and Mr. Tom M'Pherson, works manager, made the presentation, consisting of a grandfather clock. Mr. Murdoch, who is 72 years of age and has been in the service of Messrs. Hurst, Nelson for 42 years, suitably acknowledged.

Wills.

Butterfield, W. P., head of Messrs. W. P. Butterfield, Limited, tank manufacturers, of Shipley	£31,792
Oulton, W. F. B., managing director of Messrs. Dodd & Oulton, Limited, brassfounders, Liverpool	£4,780
Menzies, George M., Edinburgh, managing director of the North British Steel Foundry, Limited	£63,629
Williams, J. T., of Redcar, associated with the Linthorpe-Dinsdale Smelting Company, Limited, Middlesbrough	£11,601
Mills, Sir William, inventor of the Mills hand grenade, of Messrs. William Mills, Limited, founders, Birmingham and Sunderland	£37,829

Obituary.

Mr. Thomas Henry Mold, founder of the firm of T. H. Mold & Son, malleable-iron founders, of Walsall, died recently, aged 64.

Mr. Peter Dunn, who until recently was foreman patternmaker with Messrs. Pott, Cassells & Williamson, Limited, Motherwell, died suddenly at his residence in Gourock on May 8.

The death occurred on May 12 of Mr. George Milne, senior partner of the firm of Messrs. D. Milne & Sons, engineers, Aberdeen. Mr. Milne was responsible for numerous inventions which he patented, and for new ideas in connection with comb-making and other types of machinery.

The death occurred, at his residence, Mount Pleasant, Denny, on May 10, of Mr. William W. Hunter, J.P., in his 93rd year. Mr. Hunter at an early age succeeded his father in the business of John Hunter & Sons, sanitary engineers and brassfounders and specialising in paper-mill work. Mr. Hunter was a well-known ex-Provost of the burgh of Denny and Dunipace, and retired from active business a few years ago.

Company Reports.

Callender's Cable & Construction Company, Limited.—Dividend at the rate of 15 per cent. per annum (of which 5 per cent. was paid in November last).

Iron Trades Employers' Insurance Association, Limited.—Premium income, £542,258; dividends and interest, etc., received, £96,756; brought in, £47,096; compensation and incidental expenses, £392,019; to investments reserve fund, £52,431; balance on net revenue account, £178,212. The directors recommend that a return of 15 per cent. of the Workmen's Compensation premium for 1931, together with a bonus of 15 per cent., on which income tax has already been paid, making a total return of 30 per cent., be made to the policyholders.

Catalogues Received.

Gearwheels and Castings. — Messrs. Joseph Henry, Limited, Manor Road, Holbeck, Leeds, have favoured us with an advance copy of their latest catalogue. If the underlying principle is to instill into the mind of the buyer profound confidence in the issuing house to deliver high-grade castings, then it can be asserted that this object has been well achieved. The catalogue, which contains 28 pages, conforms to all the best principles of modern publicity matter. No overcrowding is apparent, the type has been well chosen, useful technical data are included and the ability to execute both large and small, simple and complex castings at competitive prices is stressed. The fact that a number of customers have given permission for the appearance of their names, certainly gives confidence to those with orders to place.

Transport Trucks.—The Laycock Engineering Company, of Millhouses, Sheffield, has sent us a folder which dimensions, prices and details shipping weights and measurements of a range of petrol-driven, low-loading trucks for either internal or external transport. As publicity matter, we confess to a distinct dislike of folders. Their object is to catch the eye and induce a quick sale. This folder, however, contains a mass of commercial data which one would normally wish to file, yet we suggest few people ever think of keeping folders. For a maximum of utility, the material contained in this folder should be reassembled and issued as a proper catalogue. The trucks described are of real interest to foundry owners, and of the several applications shown, two are devoted to the transport of castings at the works of Head, Wrightson and Mather & Platt.

Publications Received.

Sands, Clays and Minerals. Published Quarterly by Algernon Lewin Curtis. Chatteris, Cambs. Price 5s. per annum.

The first issue of this new house organ contains articles on Black Diamonds, Ore Sampling, Sands in British Industry, Slate, Portland Cement, Lithographic Abrasives, Precious Stones, Clay Analyses and Actinolite. The article by Mr. Curtis is easily the most interesting, for he very clearly shows how modern civilisation is dependent on the scientific and economic utilisation of the world's sand resources. This first issue contains 40 pages and is well illustrated.

Technical Report for 1930-31. Issued by the British Engine Boiler & Electrical Insurance Company, Limited, 24, Fennel Street, Manchester. Price 7s. 6d.

This annual publication becomes more and more technical and increasingly useful every year. For those interested in welding this year's report is a veritable text-book. A factor that interests us that writing without any actual statistical research we have received the impression that there are few accidents debited to the use of cast iron than was the case a few years ago. Where accidents are reported, they are due to ice, choking, water hammer and similar extraneous causes, and in only one case the accident was due to a defect in the casting. There is a small article on "The Effect of Heat on Grey Cast Iron," which is illustrated by three photomicrographs. The sample had been in use at 850 deg. C.

Institute of Welding Engineers.—Foundrymen will be interested to learn that the membership of the Institution of Welding Engineers has increased during the last year from 294 to 379. The Institution now possess branches in Manchester and Birmingham.

ACHIEVEMENTS—ENGLISH MATERIALS ONLY

Vide recent notes I.B.F. (Sheffield Branch) visit Clegg and Howgate, Bingley, reported in Foundry Trade Journal.

1. BRACKELSBERG Furnace Linings.

Outlet End gave 400 heats and still going strong.

Front End. First lining 89 heats, second 154 heats, third lining 173 heats, fourth ? ? ?

ALL WITHOUT PATCHING OR ATTENTION.

N.B. Front end receives all intense local heating and mechanical abrasion — very severe treatment.

2. CUPOLAS.

Our material rammed up to brick linings means patching every fourth day and only then in melting zone. After long service, three days of rough chipping and application new material secures new lining with correct cupola working diameter.

3. CRUCIBLE HOLES.

A longer life than the best crucible ganister is guaranteed.

4. NON-FERROUS.

Every month secures new customers for crucible holes, furnaces of all types. Much saving in costs.

5. GENERAL.

You want a fireclay with exceptional refractory properties and very cheap—we have it !

J. HINCKLEY & SON,

11, East Parade Chambers, SHEFFIELD.

(Associated with Messrs. Kingscliffe Super Refractories, Ltd.)

SILVER SAND
for Steel and Iron Founders and Glass-makers, from Cheshire.

MOULDING SANDS
for Steel Casting makers from our Durham deposits.

Raw Material Markets.

The iron and steel markets have been very quiet during the past few weeks and have shown little sign of recovery since the holiday. There is a lack of inquiries both from the home and overseas markets, while Continental material continues to influence the situation. There are still large stocks of foreign semis to contend with, and foreign basic iron finds a steady sale in Scotland and has also been offered in South Wales. The latter grade of iron is still only subject to an import duty of 10 per cent. *ad valorem*.

Pig-Iron.

MIDDLESBROUGH.—There is little demand for pig-iron in this district, and the only encouraging feature is that stocks have been brought low and the present output barely covers requirements. Only 17 furnaces are in blast on the North-East Coast, and an increase in production would soon be necessary were there any increase in business. Sales abroad show no improvement, owing to the increasing difficulties exporters have to contend with in foreign markets. Prices remain at the official minima, as follow:—No. 1 Cleveland foundry iron, 61s.; No. 3 Cleveland G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; No. 4 forge, 57s. per ton.

Prompt business in East Coast hematite has shown a slight increase lately, but the aggregate turnover is not very large. There is little forward buying, but the makers are demanding a premium before committing themselves ahead. Mixed numbers remain at 63s. 6d. per ton, and No. 1 quality at 64s., f.o.t. or f.o.b. West Coast hematite has now the advantage of an increased local consumption, but business in other markets has been on the slow side. Bessemer mixed numbers continue at 66s. per ton at works.

LANCASHIRE.—Steady deliveries of foundry iron are being made to the light-castings makers, but little support is forthcoming from the heavy engineering foundries. Few forward contracts are being arranged. For delivery to consumers in the Manchester zone, offers of Derbyshire, Cleveland and Staffordshire brands of No. 3 iron have been maintained on the basis of 67s. per ton, with Northamptonshire iron at 65s. 6d., Derbyshire forge at 62s., Scottish makes at from 86s. 6d. to 87s. and West Coast hematite at about 81s. per ton.

MIDLANDS.—On the whole, deliveries of pig-iron this month have been maintained at the April level, but new business is at a low ebb. Conditions at the iron foundries show no improvement, and many of them are taking a prolonged holiday. The prospects for the next month are not very encouraging. Prices, including delivery to Birmingham and Black Country stations, are 62s. 6d. for Northants No. 3 and 66s. per ton for Staffordshire, Derbyshire and Lincolnshire No. 3.

SCOTLAND.—In the virtual absence of business, market quotations are largely nominal. No. 3 Scottish foundry iron remains at 69s. 6d. per ton f.o.t. furnaces, with a minimum of 2s. 6d. extra for No. 1. No. 3 Middlesbrough is at 57s. 6d. per ton at Grangemouth, other English brands being at about the same level. The export trade has been very dull lately.

Coke.

There has been little movement in the foundry coke market. Welsh coke remains at 30s. to 45s., according to analysis, delivered in the Birmingham district, and best Durham coke is at 37s. 6d. to 40s. Other Durham grades are quoted at about 2s. 6d. per ton less.

Steel.

Continental semis still have a price advantage in the British markets, in spite of the 33⅓ per cent. duty, but little business is being done in either home or foreign material. A few small orders have been taken for early delivery, but that is all. The depression in the finished-steel market shows no sign of alleviation, the plate and section mills being seriously affected. There is only a medium demand for light products. Prices of British small steel bars are firmly maintained, in spite of foreign undercutting.

Metals.

Copper.—The standard market has remained steady, few orders being taken. The Exporters' general c.i.f. quotation remains at 6.25 cents, but they are also offering customs metal at 6.00 cents per lb. Outside offers are being made, however, of down to 5.625 cents c.i.f. There is little hope of any early improvement in the market. Consumption in Europe and in the United States remains on a limited scale, but it is believed that total stocks are showing a slight decrease, owing to the strong measures taken by the producers.

Closing quotations :—

Cash.—Thursday, £29 8s. 9d. to £29 10s.; Friday, £29 to £29 1s. 3d.; Tuesday, £28 5s. to £28 7s. 6d.; Wednesday, £28 5s. to £28 6s. 3d.

Three Months.—Thursday, £29 11s. 3d. to £29 12s. 6d.; Friday, £29 3s. 9d. to £29 5s.; Tuesday, £28 8s. 9d. to £28 11s. 3d.; Wednesday, £28 8s. 9d. to £28 10s.

Tin.—After a decided reaction early last week, the standard market recovered slightly, but has been weaker in the last day or two. The reason for these fluctuations is that the market is largely in the hands of professional speculators, who are easily moved by the latest rumours of output restriction, sales control, etc. There has been hardly any buying by consumers. Whether the latest schemes actually materialise remains to be seen, but it will be difficult to cut supplies down to the present abnormally low consumption.

Official closing prices :—

Cash.—Thursday, £121 to £121 5s.; Friday, £120 15s. to £121; Tuesday, £119 to £119 5s.; Wednesday, £121 7s. 6d. to £121 12s. 6d.

Three Months.—Thursday, £123 to £123 5s.; Friday, £122 10s. to £122 15s.; Tuesday, £121 2s. 6d. to £121 5s.; Wednesday, £123 12s. 6d. to £123 15s.

Spelter.—The market has shown a weak undertone, mainly owing to a general lack of interest on the part of consumers. The galvanising and brass trades, both in this country and on the Continent, have shown little activity during the last few months, and there is no sign of any early improvement. The East St. Louis spot quotation is now 2.45 cents per lb.

Daily fluctuations :—

Ordinary.—Thursday, £12 7s. 6d.; Friday, £12 7s. 6d.; Tuesday, £12 8s. 9d.; Wednesday, £12 10s.

Lead.—This metal has shown no recovery, buying on the part of consumers being restricted to present requirements. The majority of business now being done is in Empire lead. Continental consumers have not shown much interest in the market lately.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £10 16s. 3d.; Friday, £10 15s.; Tuesday, £10 13s. 9d.; Wednesday, £10 16s. 3d.

Iron and Steel Output in April.

The National Federation of Iron & Steel Manufacturers report that there were 69 furnaces in operation at the end of April, three furnaces having ceased operations for re-lining since the beginning of the month. Production of pig-iron in April amounted to 316,900 tons, compared with 335,600 last March and 323,200 tons in April, 1931. The production included 61,500 tons of hematite, 137,800 tons of basic, 96,900 tons of foundry and 13,700 tons of forge iron.

The output of steel ingots and castings amounted to 433,300 tons, compared with 462,800 last March and 397,400 tons in April, 1931.

Oil used for quenching should be sometimes filtered to remove deposits due to foreign matter, carbonisation and oxidation.

Messrs. Joseph L. Thompson & Sons, Limited, the Sunderland shipbuilders, are entering into civil engineering. The firm has obtained a contract for the supply and erection of steelwork for a footbridge over the River Tees at Cotherstone.

Notes from I.B.F. Branches.

Scottish Branch.—On the invitation of the directors of Messrs. Glenfield & Kennedy, Limited, Kilmarnock, the members of the Scottish Branch will visit the Glenfield Works on May 21.

Falkirk Section.—The annual general meeting of the section was held in Falkirk on Saturday, April 30.

The hon. secretary, Mr. G. B. Morrison, submitted a report of the sessions work, which had unfortunately not been as full as might have been desired, but the committee had been in consultation with a sub-committee of the Branch regarding arrangements for next session, and had been able to make such arrangements as to ensure a full series of meetings during session 1932-1933.

Reference was made to the removal of Mr. Cleverley from Falkirk and his resignation from the hon. secretaryship of the section, which he had held for some years. The thanks of the members for his labours was recorded.

Mr. T. Shanks was elected Chairman of the section for the ensuing year. Messrs. W. Walker and J. D. Smith were elected Vice-Chairmen, and a committee, consisting of Messrs. N. A. W. Erskine, T. B. Preston, J. M. Reid, Jnr., G. C. Wilson, Thos. Haig, Wm. Phillips, James McIntosh, J. A. Donaldson and H. McNair was elected. Mr. G. B. Morrison, of the Grangemouth Iron Company, Limited, was re-elected hon. secretary.

World Pig-Iron Production.

(*Concluded from page* 301.)

furnaces of comparatively small output compared with the large daily tonnages per furnace obtained in the United States, India and Germany. In 1929 the British proportion of the world output was about 7.85 per cent. and in 1930 just under 7.8 per cent.

It is regrettable that such illuminating figures should not be available for over a year after the close of the period to which they relate. For steel ingots and castings the figures tell the same story. The world output in 1930 was just under 79 per cent. of that for 1929, whereas the British Empire output fell in the former year to 78.5 per cent. of that for the latter. In Britain itself, however, the figure was lower, 76 per cent. British output was 8.15 per cent. of the world total in 1929 and 7.9 per cent. in 1930.

The Heterogeneity of a Sand-Cast Steel Ingot.

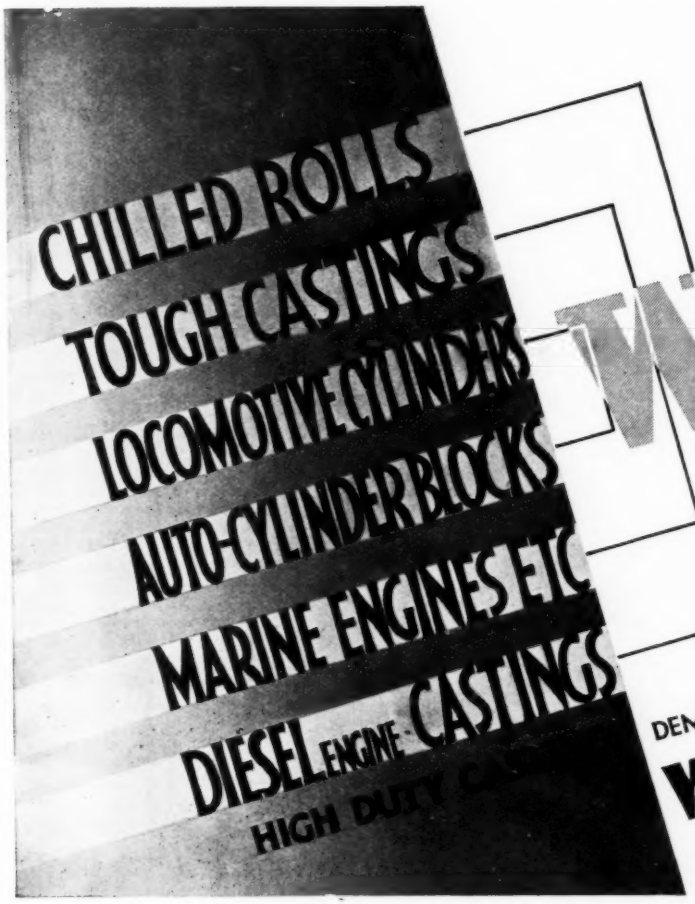
(*Concluded from page* 311.)

The distances of this region from the ingot faces and from the ingot axis are summed up in Table IV.

The fact that in the ingot made by the Harmet process the Λ-segregations reach the ingot axis was due not only to the rapid rate of cooling, but also to the compression of the metal in the conical ingot mould. The extent of the region of Λ-segregations is indicated in Fig. 4.

Chemical Composition. — As regards the chemical composition, it may be observed that in the sand-cast ingot the negative deviation in the content of elements showing marked segration (especially of carbon) from the average values was comparatively higher than in the chill-cast ingots.

A meeting of the trade creditors of Messrs. Booth Bros. (Dial Foundry), Limited, is to be held on May 20, at the offices of Mr. J. H. Ellis, Barclays Bank Chambers, Stourbridge, at 3 p.m., to consider a scheme of arrangement.



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WARNER & CO., LIMITED.

CARGO FLEET · MIDDLESBROUGH.

CAST IRON FLANGED PIPES

2 in.–12 in. & CONNECTIONS. to 24 in. dia.

WE HAVE FIFTY-TWO YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.

JAMES & RONALD RITCHIE, LTD.,

Telephone: 3852 (2 Lines). MIDDLESBROUGH. Telegrams: "Ritchie, Middlesbrough."

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

FOUNDRY Manager, with exceptional experience in the production of repetition castings, machine and hand, every description of plate work, used large output, thorough pattern knowledge, desires position; remuneration by results.—Box 168, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Works Manager desires position; practical and technical training all branches iron and non-ferrous, thorough knowledge of stainless steel, expert on cupola, experienced engineering and patternshop; good organiser.—Box 166, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

METALLURGIST and Chemist, First-class City and Guilds Ferrous and Non-Ferrous Certificate, 7 years' experience various metallurgical laboratories, desires post in foundry or works laboratory; age 22; highest references.—Box 172, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

OWING to the collapse of a large financial holding corporation, one of the best-known foundry managers is available for re-engagement. Unimpeachable references of the highest order from every concern with which he has ever been connected.—Apply, Box 176, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, expert DRAUGHTSMAN for architectural, rainwater goods, and light-castings ironfoundry business, to act as a Consultant and Representative in England. Capable of advising *re* building-front construction and art metalwork designs and facings, also taking particulars from site and quantities. Thorough knowledge of light-castings trade necessary. State experience, age, and salary expected.—Box 178, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

FOUNDRY Engineer seeks responsible position. Six years foundry manager. Hons. B.Sc. (Mech. Engineering). Drawing-office and good practical experience. Age 35. (174)

POSITION required as Foundry Foreman. Has had experience in similar capacity with well-known firms on steam engines, turbines, oil engines, iron- and steel-works plant. Iron castings up to 20 tons. Brass foundry and patternshop. Machine-moulding and sand-slinger experience. (175)

FOUNDRY Manager desires engagement. Had first-class experience in modern foundry practice, practical, technical and metallurgical. Grey-iron castings up to 45 tons. Non-ferrous 15 tons. Expert repetition knowledge. Age 44. (176)

SITUATIONS VACANT AND WANTED—*Contd.*

FOREMAN MOULDER seeks position; 10 years in charge of plate and machine foundry of large engineering firm. Excellent references. Age 48. (177)

AGENCIES

AGENT.—Old-established Founders in Iron and Aluminium Castings require the services of an Agent to handle sales in Lancashire, Yorkshire and North-East Coast on a commission basis. Knowledge of castings trade essential. State experience, nature of present agencies held, and ground covered.—Box 182, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Agents with established connections, for Scotland, Midlands and Home Counties, to represent manufacturers of well-known brand of Core Binders.—Fullest particulars to Box 180, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PROPERTY.

MAGNIFICENT

11 ACRES WORKS SITE.

SHEFFIELD.

145,000 Sq. Ft. of Shops.

SIDING CONNECTIONS

with L.M. & S. and L. & N.E. Rlys.

WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

SALE BY PRIVATE TREATY.

FOR SALE BY PRIVATE TREATY.
ENGINEERING WORKS, YORK,
including
RANGE OF MACHINE SHOPS AND FOUNDRY
(completely equipped with Modern Machinery and Tools, etc.),
OFFICE BUILDINGS, LARGE PRIVATE HOUSE (with land available for extension).

The whole of the property, which extends to 3½ acres, is freehold, and the buildings and machinery are in a good state of repair throughout.

Facilities for Rail and Road Transport.

Full particulars may be obtained from BARRON & BARRON, Chartered Accountants, 1, Minster Gates, York.

MACHINERY.

IONIDES Gas-fired Melting Furnace. Tilter type. Capacity 300 lbs. aluminium, with 3-in. Pressure Balance. Practically unused. What offers?—COVENTRY MALLEABLE & ALUMINIUM, LIMITED, Lincoln Street, Coventry.

THOS. W. WARD, LTD.

130, 100 and 60 cub. ft. cap. Petrol-driven Air Compressors.

3" & 4" Petrol-engined Diap. Suction Pumps.

36" Saw Bench, Rise and Fall Spindle.

Chain and Hollow Chisel Mortising Machine, cap. 12" x 6".

New VERT. C.T. BOILER, 7' 6" x 3' 3", 100 lbs. press.

ALBION WORKS, SHEFFIELD.

'Grams: Forward, Sheffield. 'Phone, 23001.

"Albion" Catalogue on application.

MACHINERY—*Continued.*

WHEEL Moulding Machines. One each 4 ft. 6 in., 5 ft. 0 in. and 6 ft. 0 in. Machines, new, to be sold at much-reduced prices.—Write for particulars, BUCKLEY & TAYLOR, LIMITED, Oldham.

'Phone: 287 SLOUGH

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12-Ton "Stevenson"	... ...	£48
9-Ton "MacNeil"	... ...	£42
4-Ton "Evans"	... ...	£28
3-Ton "Evans"	... ...	£24
2-Ton "Evans"	... ...	£19

PNEUMATIC MACHINES

14"×16" Mumford split pattern	2 @ £35
No. 2 Britannia Jolters	... 2 @ £36
No. 0 Britannia Jolters	... 4 @ £20
Core Jolters, 3" Cylinder new, unused	... £4 each

ABOVE ARE AS NEW.

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ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

To Engineers, Founders, Manufacturers. Fine site of nearly 3 acres on Arterial Road with Foundry and Workshops and own Rail Sidings into premises. Modern Offices, Warehouse and Workrooms. Central Heating.

CHARLES A. TRICKS & SON,
Auctioneers,
ST. NICHOLAS STREET, BRISTOL.

PETER—WITH ONE EXCEPTION

With one exception Peter is an ordinary little fellow. Chubby, likeable, just five-and-a-half, full of life and fun, and on occasions—be it admitted—of naughtiness. Just now Peter's rather important, for this is his first term at school, and he's grappling with the intricacies of "A B C" and "Twice-Two": difficult subjects to all men of five-and-a-half, but even more difficult in Peter's case because—bad luck—he's totally blind. That's his One Exception. Peter learns reading, writing, and 'rithmetic through the medium of "Braille"—dull stuff compared with the coloured picture books of most five-and-a-halfs. However, he's a stout lad is Peter, and he's making great progress.

Would you like to know more about him? How, in spite of his "One Exception," he is being educated and, when older, technically trained and usefully employed.

There is a long waiting list of "Peters" throughout the British Isles, for whom training and accommodation must be provided in the immediate future.

Will you help with a donation or annual subscription? Any sum, large or small, will be gratefully received.

Here's a suggestion. Your eyesight is worth 3d. a year to you. Send Peter and his handicapped pals 3d. for every year you've had it. Now, please, in case it slips your memory. Good idea?

The Chairman,

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(FOUNDED 1838)
SWISS COTTAGE, LONDON, N.W. 3